N6 Galway City Ring Road
Environmental Impact Assessment Report

Galway City
Transport Project

Volume 2
Report

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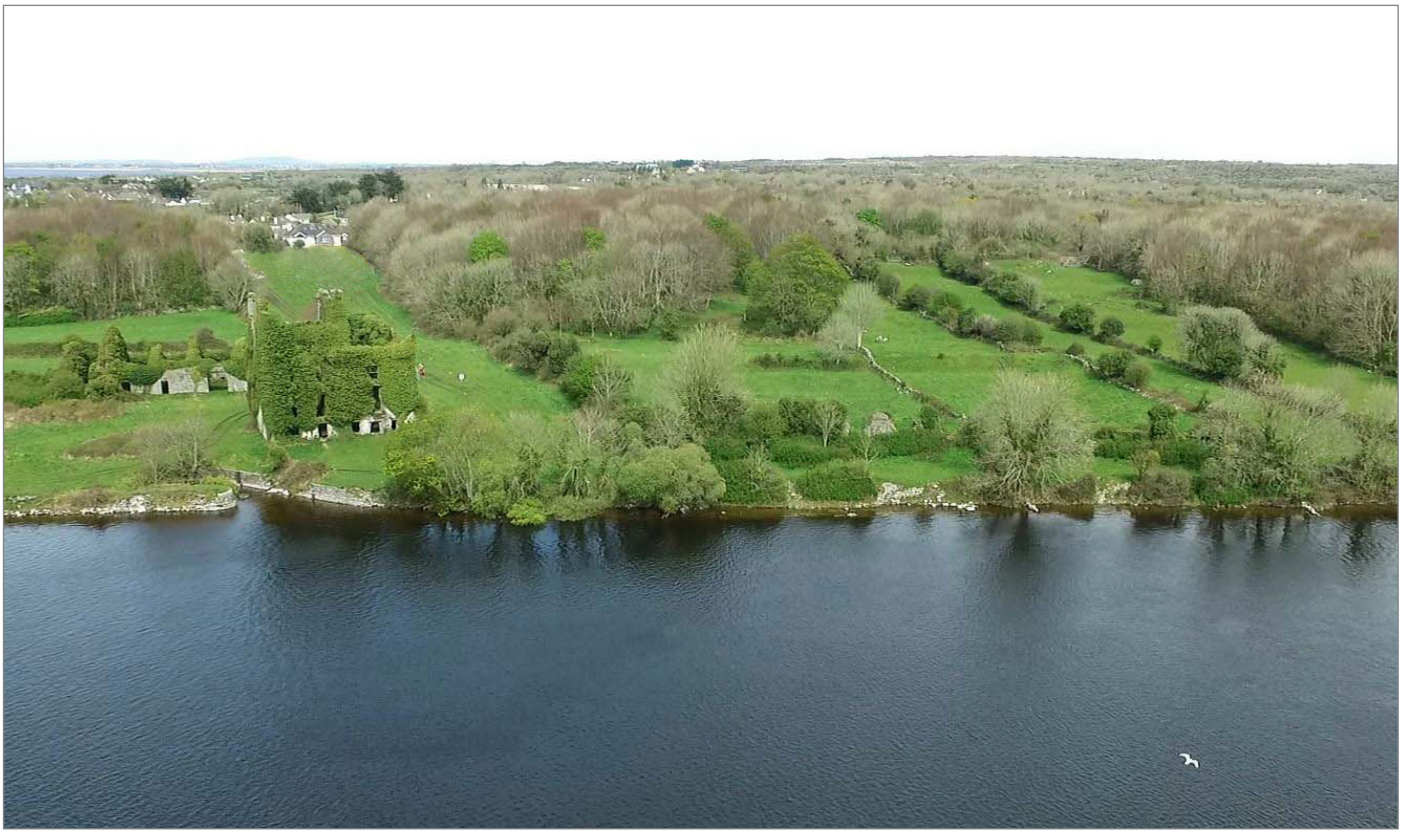

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Glossary of Terms

Terms	Meaning
AADT	Annual Average Daily Traffic (expressed in vehicles per day)
AA	Appropriate Assessment An assessment carried out under Article 6(3) of the Habitats Directive of the implications of a plan or project, either individually or in combination with other plans and projects, on a European site in view of the site's conservation objectives.
ABP	An Bord Pleanála
Acquisition	Property that is to be purchased by the local authority.
ADMS-Roads model	The ADMS-Roads pollution model is a comprehensive tool for investigating air pollution problems due to networks of roads that may be in combination with industrial sites, for instance small towns or rural road networks.
Alkalinity	Is a measure of the ability of a solution to neutralise acids.
Alluvium	Sediment deposited by flowing water.
Annex I habitat	Habitat types listed on Annex I of the EU Habitats Directive whose conservation requires the designation of Special Areas of Conservation.
Annex II species	Species listed on Annex II of the EU Habitats Directive whose conservation requires the designation of Special Areas of Conservation.
Annex IV species	Species listed on Annex IV of the EU Habitats Directive which are afforded strict protection under EU and national legislation.
aOD	Above ordnance datum
Aquifer	A subsurface layer or layers of rock that store and transmit water in significant quantities.
Arterial Drainage	Artificial drainage work carried out to support natural drainage networks.
Attenuation pond	Water pond used for the collection and slow release of water runoff from the road.
At-Grade Junction	Junction where roads converge at the same level.
At-grade signalised junctions	Road junction, where roads converge at the same level, which is controlled by traffic signals.
AQS	Air Quality Standards
Baronies	The historical subdivision of a county.
Baseflow	The background level of flow of water in a stream or other surface water feature during dry periods (which in many cases will be due solely to groundwater discharge).
Base year	Year used as the beginning or the reference year for constructing a design model or equation.
Batholith	A very large igneous intrusion extending to an unknown depth in the earth's crust.

Terms	Meaning
Bathymetric	Bathymetry is the measurement of the depth of water in oceans, rivers, or lakes. Bathymetric maps look a lot like topographic maps, which use lines to show the shape and elevation of land features.
BCI	Bat Conservation Ireland
Benthic	Relating to the bottom of a sea or lake or to the organisms that live there.
Biodegradation	Biodegradation is the decomposition of organic material by micro-organisms.
Biological Oxygen Demand (BOD)	A parameter used to quantify how fast biological organisms use up oxygen in a body of water. The testing for BOD is not an accurate quantitative test, although it could be considered as an indication of the quality of a water source.
Biotite	Biotite is a name used for a large group of black mica minerals that are commonly found in igneous and metamorphic rocks.
Bivalves	An aquatic mollusc which has a compressed body enclosed within a hinged shell, such as oysters, mussels, and scallops.
Blasting	Breaking apart or blowing up solid rock with explosives
Bored tunnel	The excavation of a tunnel using a machine with circular cross section through rock, i.e. the constructed using a boring machine.
BoCCI	Birds of Conservation Concern in Ireland
BRE	Buildings Research Establishment
BSBI	Botanical Society of Britain & Ireland
Bullaun stone	Bullaun is the term used for the depression in a stone which is often water filled. A Bullaun Stone is a large rock where a basin or bullaun has been carved out.
BWI	BirdWatch Ireland
cSAC	candidate Special Area of Conservation
Calcite	Calcite belongs to the calcite group of minerals, a group of related carbonates that are isomorphous with one another. They are similar in many physical properties, and may partially or fully replace one another, forming a solid solution series.
Catchment	The entire surface area feeding water to a given surface or groundwater feature.
Carriageway	The particular part of the road used by vehicular traffic.
C_6H_6	Benzene
CEMP	Construction Environmental Management Plan
Ch.	Chainage
Cherry picker	A hydraulic crane with a railed platform at the end for raising and lowering people, for instance to work on overhead cables
Chlorophyll	Chlorophyll is a green pigment found in most plants, algae, and cyanobacteria.
CIRIA	Construction Industry Research and Information Association
CO	Carbon Monoxide

Terms	Meaning
CO_2	Carbon Dioxide
Conductivity	Conductivity (or specific conductance) of a solution is a measure of its ability to conduct electricity. It is linked directly to the total dissolved solids in the solution.
Conservation objectives	The overall target for the species and/or habitat types for which an SAC or SPA site is designated in order for the site to contribute to maintaining or reaching favourable conservation status of those species and/or habitat types. For some SAC/SPA sites this includes a detailed set of targets and attributes against which favourable conservation status can be measured.
Construction stage	The stage during which the proposed road development (N6 Galway City Ring Road) will be constructed. This includes advance contracts such as fencing, archaeological testing and the diversion of utilities/services, site set up and mobilisation.
Conveyance	The ability of a river to carry water flow
Climbing lanes	A climbing lane is an additional lane in a road carriageway that allow slower travel for large vehicles ascending a steep grade. Since climbing uphill is difficult for these vehicles, they can travel in the climbing lane without slowing traffic.
Cofferdam	A watertight enclosure pumped dry to permit construction work below the waterline, for example foundations for a bridge structure.
Collection System	A system of gathering, sorting or mixing of waste for the purpose of it being transported to a waste recovery or disposal facility.
Conduit flow	Groundwater flow though large conduits within the rock mass typical of karstic aquifers.
Culvert	A structure that allows water to flow under an obstruction such as a road or railway.
Compulsory Purchase Order (CPO)	National laws which allow local authorities to compulsorily purchase land necessary for the construction or operation of the N6 Galway Ring Road without the necessity of obtaining consent from the owners subject to approval by An Bord Pleanála.
cSAC	candidate Special Area of Conservation
CSO	Central Statistics Office
Cu	Copper
Cumec	A cubic metre per second, as a unit of rate of flow of water
Cumulative Impacts	For definition, see extract from EPA 2017 draft guidelines at end of this document
Cut and cover tunnel	‘Cut and cover’ is an approach used for constructing shallow tunnels in situations where all the ground above the tunnel can be cleared (cut), the structural element for the tunnel is then constructed before the top of the tunnel is covered over with earth, topsoil and grass
DCHG	Department of Culture, Heritage and the Gaeltacht
DAU	Development Applications Unit of the DCHG
dB (decibel)	The unit of sound pressure level, calculated as a logarithm of the intensity of sound.

Terms	**Meaning**
dB(A)	Unit used to measure the intensity of sound. The “A” denotes that levels were “A” weighted
Design year	The design year is the year for which future traffic demand and volume is calculated and is set at 2039 - 15 years following the year of opening of the proposed road development
Design Goal (noise and vibration)	A target limit for noise or vibration adopted during the early design stages of a project, not necessarily having a statutory basis but based on current best practice and the particular circumstances of a given project.
Designated sites	Sites which have special status as protected areas because of their natural and cultural importance.
DHPLG	Department of Housing, Planning and Local Government
DEFRA	UK Department for Environment, Food and Rural Affairs
Diamond junction	A diamond junction is a common type of a grade separated road junction, used where a major road crosses a minor road.
Diffuse flow	Laminar groundwater flow which takes place through the aquifer matrix or grains.
DMRB	Design Manual for Roads and Bridges, UK
“Do-Nothing” Scenario	The environment as it would be in the future should the proposed road development not be developed
Do Minimum Scenario	This scenario assumes that basic maintenance of the road as well as likely and committed transportation schemes are carried out.
Do Something Scenario	This scenario assumes that the proposed road development is constructed as described, and includes other committed road developments and considers the environment should the proposed road development be developed.
DTTaS	Department of Transport, Tourism and Sport
Dolerite	A dark, medium-grained igneous rock, typically with ophitic texture, containing plagioclase, pyroxene, and olivine. It typically occurs in dykes and sills
Doline	A shallow usually funnel-shaped depression of the ground surface formed by solution in limestone regions
Drawdown	A withdrawal of water from a reservoir or repository.
Dykes	A subvertical sheet-like intrusion of magma or sediment.
Effects	For definition, see extract from EPA 2017 draft guidelines below. The term effects and impacts are used interchangeably in this EIA Report to mean the same thing.
Effective rainfall	That part of the total precipitation which remains after evaporation and which is available for vegetation and percolation.
Electromagnetic induction (quadrature) survey	The electromagnetic (EM) induction survey is based on the measurement of the change in mutual impedance between a pair of coils on or above the earth’s surface.
EQS	Environmental Quality Standard
EIA	Environmental Impact Assessment

Terms	**Meaning**
EIS	Environmental Impact Statement. An EIA Report was formerly known as an EIS. Throughout this document, where reference is made to 'environmental impact statement', or 'EIS', it should also be understood to mean 'EIA Report'.
EIA Report / EIAR	Environmental Impact Assessment Report An EIA Report was formerly known as an EIS. Throughout this document, where reference is made to 'environmental impact statement', or 'EIS', it should also be understood to mean 'EIA Report'.
Enabling works	Preparations to make a site ready for construction. It covers activities from site preparation, creation of access routes, and the installation of facilities like security fencing, ramps, and placing of signs.
EPA	Environmental Protection Agency
EPA Digital Soils Data	With the assistance of Teagasc and the Geological Survey of Ireland, the EPA produced a soils map for the Republic of Ireland. This data is available in a digital format which can be used in computer mapping software.
Epikarst	The thin zone near the karst surface. It includes the solutionally modified (karren) bedrock surface and the overlying and included regolith. The epikarst frequently supports a perched aquifer and serves to retard and store infiltrating rainwater. It also serves as a habitat for a variety of organisms that live in the interstices.
Estavelles	Estavelles are orifices with a dual function. They either discharge water as a spring or allow water to sink, depending on groundwater conditions. Typically estavelles are the connection of karst lakes with the karst ground water table.
EU	European Union
European site	Collective term used in national legislation when referring to nature conservation sites protected under the Habitats or Birds Directives (i.e. SAC or SPA sites).
Evapotranspiration	The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.
Fault	A planar fracture in rock in which the rock on one side of the fracture has moved with respect to the rock on the other side.
Favourable Conservation Condition	In the context of assessing effects on the QIs/SCIs of European sites and their conservation objectives, favourable conservation condition is achieved when the QI habitats have sufficient range, area and quality, and QI/SCI species have a sufficient population size range and habitat area, to ensure their survival into the medium to long term, along with favourable future prospects in the face of pressures and threats.
Favourable Conservation Status	In the context of assessing the conservation status of Annex I habitats and Annex II/IV species at a national level, favourable conservation status is achieved when the habitats have sufficient range, area and quality, and the species have a sufficient population size range and habitat area, to ensure their survival

Terms	Meaning
	into the medium to long term, along with favourable future prospects in the face of pressures and threats.
Fissure	Natural crack in rock which allows rapid water movement.
FPO	Flora (Protection) Order, 2015
FRA	Flood Risk Assessment
Fracture	A discontinuity across which there has been separation.
Geohazards	Geological conditions capable of causing damage, or loss of property and life, are called geological hazards and commonly referred to as "geohazards".
Geomorphology	the study of the physical features of the surface of the earth and their relation to its geological structures
Geothermal well	Geothermal wells are wells which tap into the natural geothermal energy found beneath the Earth's crust.
GHG	Greenhouse Gases
GI	Ground Investigation
GIS	Geographic Information System
GNI	Gas Network Ireland
Glacial erractics	A boulder transported and deposited by a glacier having a lithology different than the bedrock upon which it is sitting. Erratics are useful indicators of patterns of former ice flow.
Gleys	A subdivision of the podzolic soil group which are characterised by a fluctuating groundwater table or by impeded drainage which causes mottling in the gleyed grey horizon that is overlain by a dark brown or black subsurface horizon.
Grade Separated Junction	Road junction where roads converge and at which at least one road passes over another.
Groundwater	That part of the subsurface water that is in the saturated zone, i.e. below the water table.
Groundwater vulnerability	Vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities.
Growth forecasts	The process of attempting to predict the future condition. This involves the use of statistical models utilizing variables sometimes called indicators.
GSI	Geological Survey of Ireland
GTS	Galway Transport Strategy – an overall transport strategy for Galway City and its environs with a clear implementation framework for transportation over the next 20 years.
GWDTE	Groundwater Dependent Terrestrial Ecosystems
Habitat	The dwelling place of a species or community which provides a particular set of environmental conditions.
ha	Hectare (one hectare is equal to 10,000 square meters)
HAWRAT	Highways Agency Water Risk Assessment Tool
HGV	Heavy Goods Vehicle

Terms	Meaning
High growth scenario	This assumes a high growth rate in the population forecasts for the region.
Horizontal Alignment	Direction and course of the roadway in plan.
Hydraulic barrier	A general term referring to modifications of a ground-water flow system to restrict or impede movement of contaminants.
Hydrodynamics	The branch of science concerned with forces acting on or exerted by fluids (especially liquids).
Hydrocarbon interceptor	Trap used to filter out hydrocarbon pollutants from rainwater runoff. It is typically used in road construction to prevent fuel contamination of streams carrying away the runoff.
Hydrometric Area	An area defined by the EPA covering a region of river catchments.
Hypertension	Abnormally high blood pressure and especially arterial blood pressure.
Hummocky	An elevated tract of land rising above the general level of a marshy region.
Hz	Hertz
IEEM	Institute of Ecology and Environmental Management
IFI	Inland Fisheries Ireland
IGI	Institute of Geologists of Ireland
Impact	For definition, see extract from EPA 2017 draft guidelines below. The term effects and impacts are used interchangeably in this EIAR to mean the same thing.
ITS	Intelligent Transport System
In combination impacts/effects	Term for cumulative impacts used when considering impacts on European sites in the context of an NIS/AA – cumulative effects caused by a project currently under consideration together with the effects of any existing or proposed projects or plans.
In-situ	In its original place, for archaeology it refers to the preservation of archaeological sites/features without disturbance.
Intermodal (transport)	Describes the use of multiple modes of transportation (e.g. rail, ship and truck).
Intertidal zone	The intertidal zone, also known as the littoral zone, in marine aquatic environments is the area of the foreshore and seabed that is exposed to the air at low tide and submerged at high tide, i.e. the area between tide marks.
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control
IRP	Incident Response Plan
Karst	Terrain created by limestone solution and characterised by a virtual absence of surface drainage, a series of surface hollows, depressions and fissures, collapse structures and an extensive subterranean drainage network.

Terms	Meaning
Karstic	Descriptor for bedrock conditions in limestone that contain solution features such as fissures and caves, and potentially, underground watercourses.
Karstification	Formation of the features of karst topography by the chemical, and sometimes mechanical, action of water in a region of limestone, dolomite, or gypsum bedrock.
KER	Key Ecological Receptors
km	Kilometres
kph	Kilometers per hour
kPa	Kilopascal, a unit of pressure measurement
kV	A unit of electromotive force, equal to 1000 volts.
LAP	Local Area Plan
Landscape Character Area (LCA)	Distinct types of landscape which are generic in character in that they may occur in different parts of the country, but wherever they are they share broadly similar combinations of geology topography, drainage patterns, vegetation and historical land use and settlement pattern.
LED	Light-emitting diode: a device that produces a light, especially on electronic equipment
L_{10}	The noise level exceeded for just 10% of a sample period. $L_{10(1hour)}$ is therefore the noise level exceeded for 10% of the time over a period of one hour. $L_{10(18hour)}$ is the arithmetic average of the eighteen $L_{10(1hour)}$ values between 06:00 and 24:00hrs.
L_{90}	The noise level exceeded for 90% of a sample period; typically used as a descriptor for background noise level.
L_{max}	The instantaneous maximum sound level measured during a sample period.
$L_{eq,T}$	The equivalent continuous sound level - the sound level of a steady sound having the same energy as a fluctuating sound over a specified measuring period T. T may be as short as 1 second when used to describe a single event, or as long as 24 hours when used to describe the noise climate at a specified location. $L_{eq,T}$ can be measured directly with an integrating sound level meter.
L_{den}	The day-evening-night composite noise indicator adopted by the EU for the purposes of assessing overall annoyance. L_{day} is the A-weighted long term average sound level as defined in ISO1996-2: 1987, determined over all the day periods of a year. L_{night} is the A-weighted long term average sound level as defined in ISO1996-2: 1987, determined over all the night periods of a year.
$L_{evening}$	The A-weighted long term average sound level as defined in ISO1996-2: 1987, determined over all the evening periods of a year.
L_{day}	The A-weighted long term average sound level as defined in ISO1996-2: 1987, determined over all the day periods of a year.
L_{night}	L_{night} is the A-weighted long term average sound level as defined in ISO1996-2: 1987, determined over all the night periods of a year.

Terms	Meaning
Lithosols	A thin soil consisting mainly of partially weathered rock fragments.
Low growth scenario	This assumes a low growth rate in the population forecasts for the region.
Luft	TA Luft Guidance Technical Instructions on Air Quality Control
Macro-economics	Macroeconomics is a branch of the economics field that studies how the aggregate economy behaves. In macroeconomics, a variety of economy-wide phenomena is thoroughly examined such as, inflation, price levels, rate of growth, national income, gross domestic product and changes in unemployment.
Macro-invertebrates	Animals without backbones that are big enough to see with the naked eye.
Made Ground	Deposits which have accumulated through human activity and may consist of natural materials, e.g. clay and/or man made materials
Magnetometer surveys	A magnetometer is an instrument that measures magnetism—either the magnetization of a magnetic material like a ferromagnet, or the direction, strength, or relative change of a magnetic field at a particular location.
Meander	A meander in general is a bend in a watercourse.
Medium growth scenario	This assumes a medium growth rate in the population forecasts for the region.
Mesotrophic	A lake or pond that has a moderate amount of plants.
mgbl	Metres below ground level
Micro-climatic	The atmospheric conditions affecting an individual or a small group of organisms, especially when they differ from the climate of the rest of the community.
Microelectronic	Microelectronics is a subdivision of the field of electronics that deals with very small and microscopic elements to manufacture electronic components.
Mode share	The share of people using a particular mode of transport (including cycling and walking) within the overall transport usage of an urban area. Modal share can be calculated for passenger and freight (logistics) transport based on different units, such as number of trips, volume, weight, passenger-km or tonne-km.
Morphology	Morphology is the science of the forms of natural water bodies such as rivers, lakes, estuaries, lagoons, coastal zones and seas, as well as with the processes that create and modify these forms.
N6 GCRR	N6 Galway City Ring Road, the subject of the EIAR
N6 GCTP	N6 Galway City Transport Project
N6 GCOB	A previous application to ABP in 2006 for the then defined 'N6 Galway City Outer By-pass' (GCOB)
NHA	Natural Heritage Area
NIAH	National Inventory of Architectural Heritage
NIS	Natura Impact Statement
NMS	National Monuments Service

Terms	Meaning
Notice to Treat	This notice requests property owners whose lands are subject to a compulsory purchase order (CPO) to submit their claim for compensation for lands being taken under the CPO. Land values etc. are assessed with reference to the date of this Notice.
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NPF	National Planning Framework
NPWS	National Parks and Wildlife Service
NRA	National Roads Authority
NTA	National Transport Authority
NTS	Non-Technical Summary
O_2	Oxygen
OD	Ordnance Datum
Oligotrophic	Characterized by a low accumulation of dissolved nutrient salts, supporting but a sparse growth of algae and other organisms, and having a high oxygen content owing to the low organic content.
Orbital route	A route that takes traffic around a city rather than through it.
Online/On-line	The route whereby the proposed road development remains on the same alignment as the existing road infrastructure.
OPW	The Office of Public Works
Operational phase	The period of time in which the proposed road is in use.
OS	Ordnance Survey
OSI	Ordnance Survey Ireland
Outcrop	An exposure of bedrock
PAH	Polycyclic Aromatic Hydrocarbons
Paleokarst	The general term for ancient karst features that have been fossilized or preserved. Most commonly these features are filled with lithified sediments.
Paleolandscape	A landscape as it was in ancient times.
Parent material	The bedrock type from which the rock fragments within a till are derived. For instance, the parent material of a Limestone Till is Limestone.
Particulate Matter	Tiny particles of solid or liquid suspended in liquid or gas.
Pb	Lead
Permeability	A measure of the ability of a given rock to transmit water.
PMGs	Project Management Guidelines
PM_{10}	Particulate matter measuring 10 micrometers (microns) in diameter or less.
$PM_{2.5}$	Particulate matter measuring 2.5 micrometers (microns) in diameter or less.
pNHA	proposed Natural Heritage Area

Terms	Meaning
Priority junctions	Priority junctions are the most common form of junction arrangement. They required one or more minor road to yield or stop for the major road traffic flow.
Pre-earthworks drains	Where surface water and sub-surface water from adjoining land will flow towards the road, it will generally be necessary to construct intercepting drains at the tops of cuttings and the toes of embankments. In rural areas these may be ditches rather than filter drains because of their greater capacity and comparative cheapness.
Priority Annex I habitat	Annex I habitat types which are in danger of disappearance, and for which the European Community has particular responsibility in view of the proportion of their natural range which falls within the territory
Protected road	A protected road, as defined under Section 45 (1) of the Roads Act, means a public road or proposed public road specified to be a protected road in a protected road scheme approved by An Bord Pleanála. A protected road scheme approved by An Bord Pleanála may provide for the prohibition, closure, stopping up, removal, alteration, diversion or restriction of any specified or all means of direct access to the protected road from specified land or from specified land used for a specified purpose or to such land from the protected road.
Qbar	The mean annual maxima flow recorded or calculated at a location.
pH	pH is a measure of the acidity or basicity of a solution.
Pluvial flooding	This flooding occurs when surface water accumulating from the result of intense rainfall saturates the urban drainage system, and the excess water cannot be absorbed.
Podzols	A type of soil formed in cool, seasonally humid climatic regions where leaching (percolation of water) is a dominant process.
Proposed Road Development	The proposed N6 Galway City Ring Road which is the subject of assessment of this Environmental Impact Assessment Report and application to An Bord Pleanála.
Proposed Development Boundary	The extents of the lands to be compulsory acquired for the construction and operation of the proposed road development is referred to as the proposed development boundary
QI	Qualifying Interest – Annex I habitat or Annex II species for which a cSAC/SAC is designated under the Habitats Directive.
Radio-tracking	Use of radio receivers, directional antennae and radio-transmitters (attached to the target species) to monitor and record species movements and locations.
Receptors	Receptors are people or other organisms that may have sensitivity or exposure to contaminants by virtue of their age and health (e.g. schools, day care centres, hospitals, nursing homes), status (e.g. sensitive or endangered species), proximity to the contamination, dwelling construction (e.g. basement), or the facilities they use (e.g. water supply well).
Recharge	The addition of water to the zone of saturation; also, the amount of water added.

Terms	Meaning
Regosols	A Regosol is a very weakly developed mineral soil in unconsolidated materials. Regosols are extensive in eroding lands, in particular in arid and semi-arid areas and in mountain regions.
Resitivity	A measure of the resisting power of a specified material to the flow of an electric current.
Rhizome	Underground stem of plants, laterally growing and capable of producing the root and shoot system of a new plant.
Riparian vegetation	Riparian vegetation is the diversity of native vegetation contained on 'land which adjoins or is influenced by a body of water. Riparian habitats have been defined as places 'where terrestrial and aquatic ecosystems meet’.
Rijkswaterstaat (RWS) fire curve	The RWS curve was developed by the Rijkswaterstaat, Ministry of Transport in the Netherlands. This curve is based on the assumption that in a worst case scenario, a 50 m^3 fuel, oil or petrol tanker fire with a fire load of 300MW could occur, lasting up to 120 minutes. The RWS curve was based on the results of testing carried out by TNO in the Netherlands in 1979.
RMP	Record of Monuments and Places
Road bed	The portion of public road which is typically in private ownership over which there is over which there is a public right of way.
Rockhead	A raised rocky area or prominence; a summit or extremity of rock. The upper surface of bedrock.
Rock outcropping	The part of a rock formation that appears above the surface of the surrounding land.
RPS	Record of Protected Structures
RSA	Road Safety Authority
Runoff	Water leaving a drainage area or water running across the land surface.
SAC	Special Area of Conservation
Saturated zone	The zone below the water table in which all pores and fissures are full of water. Also known as the phreatic zone.
SCI	Special Conservation Interest – Annex I bird species for which an SPA is designated under the Birds Directive
Section 85 Agreement	A Section 85 Agreement has been entered into under the provisions of Section 85 of the Local Government Act 2001 between Galway County Council and Galway City Council and approved by Transport Infrastructure Ireland (TII) pursuant to Section 14 of the Roads Act 1993, as amended.
Sensitivity	Vulnerability of a sensitive receptor to change.
SEVESO	Seveso site – sites identified as containing large quantities of dangerous substances.
Severance	Where a portion of land is separated or isolated from the main land holding or where a portion of habitat is separated/isolated form the main habitat area.
SI	Site Investigation

Terms	Meaning
S.I.	Statutory Instrument
Signalised junction	Road junction where roads converge and traffic flow is controlled by traffic signals.
Stopping sight distances	Is the minimum sight distance available on a road at any spot having sufficient length to enable the driver to stop a vehicle upon sight of a hazard while, traveling at the design speed safely without collision with any other obstruction.
striation	Any of a number of scratches or parallel grooves on the surface of a rock, resulting from the action of moving ice, as of a glacier.
SMR	Sites and Monuments Record
SO_2	Sulphur Dioxide
SOx	Sulphur Oxides expressed as Sulphur Dioxide
SPA	Special Protection Area
Sub-catchment	A portion of a river catchment.
Subsoils	The material between the topsoil and the bedrock.
Subtidal zone	Subtidal zone is that portion of a tidal-flat environment which lies below the level of mean low water for spring tides. Normally it is covered by water at all states of the tide. The word is often used as a general descriptive term for a subaqueous but shallow-marine depositional environment.
Substructure	An underlying or supporting structure
SuDS	Sustainable urban drainage systems (SuDS) are a natural approach to managing drainage in and around properties and other developments. They work by slowing and holding back the water that runs off from a site, allowing natural processes to break down pollutants.
Superstructure	A structure built on top of something else.
SPA	Special Protection Area (for birds). Part of the Natura 2000 network of European sites, designated under the EU Birds Directive (79/409/EEC).
TEN-T	The Trans-European Transport Networks (TEN-T) are a planned set of road, rail, air and water transport networks in the European Union. The TEN-T networks are part of a wider system of Trans-European Networks (TENs), including a telecommunications network (eTEN) and a proposed energy network (TEN-E or Ten-Energy).
TII	Transport Infrastructure Ireland
TII PAG	Transport Infrastructure Ireland (TII) Project Appraisal Guidelines
TOC	Total Organic Carbon
Traffic control measures	Are markers, signs and signal devices used to inform, guide and control traffic, including pedestrians, motor vehicle drivers and bicyclists. These devices are usually placed adjacent, over or along the highways, roads, traffic facilities and other public areas that require traffic control.

Terms	Meaning
Trans-national network	Means the organisation mode that governs the functioning of the European projects. The network associates partners from different countries with the aim of following one or more common objectives, without any one of the partners having a higher status than the others. The network appears as the most suitable instrument to operate at the European scale and to work within the given period.
Tufa	A porous rock composed of calcium carbonate and formed by precipitation from water, e.g. around mineral springs.
Turbidity	Turbidity is the measure of relative clarity of a liquid. It is an optical characteristic of water and is an expression of the amount of light that is scattered by material in the water when a light is shined through the water sample. The higher the intensity of scattered light, the higher the turbidity.
Turlough	Seasonal lakes found in the lowland karsts of western Ireland.
Scheme study area	The term “scheme study area”, when used in this EIAR, refers to the wider study area at which constraints were initially identified during the constraints and route selection studies for the project.
Secondary permeability	Permeability derived from fissures, faults and conduits in the rock rather than that provided by the rock matrix itself.
Seep	A diffuse discharge of groundwater.
Seepage	The slow escape of a liquid through porous material or small holes.
Seismic	Geological surveying methods involving vibrations produced artificially by explosions.
Soil retention	Soil water retention is a major soil hydraulic property that governs soil functioning in ecosystems and greatly affects soil management. Soil moisture forms a major buffer against flooding, and water capacity in subsoil is a major steering factor for plant growth.
Stabilisation	The process of making something physically more secure or stable.
Study area	The area studied in order to inform the Environmental Impact Assessment. The study area will vary depending on the environmental factor being considered
Unsaturated zone	The zone between the land surface and the water table, in which pores and fissures are only partially filled with water. Also known as the vadose zone.
µg/m3	micrograms per metre cubed
Vernacular structures	Building constructed from locally available materials following traditional building practice and patterns and not architect-designed.
Vertical Alignment	Direction and course of the roadway in profile.
Viaduct	A long bridge-like structure, typically a series of arches, carrying a road or railway across a valley or other low ground.
Visual Amenity	The value of a particular area or view in terms of what is seen
VOC	Volatile organic compounds (VOC).

Terms	Meaning
Water table	The uppermost level of saturation in an aquifer at which the pressure is atmospheric.
WFD	Water Framework Directive
WHO	World Health Organization
Windblow	Carried or driven by the wind
Windrose	Map diagram that summarizes information about the wind at a particular location over a specified time period.
Windshield Survey	This is a survey carried out from the roads throughout the study area.
Zone of Contribution	The groundwater catchment area that contributes water to a well.
ZoI	Zone of Influence
%ile	Percentile

Extract from EPA EIAR Guidelines August 2017, page 50-52 Table 3.3 Description of Effects[1]

Quality of Effects It is important to inform the non- specialist reader whether an effect is positive, negative or neutral	**Positive Effects** A change which improves the quality of the environment (for example, by increasing species diversity; or the improving reproductive capacity of an ecosystem, or by removing nuisances or improving amenities).
	Neutral Effects No effects or effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error.
	Negative/adverse Effects A change which reduces the quality of the environment (for example, lessening species diversity or diminishing the reproductive capacity of an ecosystem; or damaging health or property or by causing nuisance).
Describing the Significance of Effects ''Significance' is a concept that can have different meanings for different topics – in the absence of specific definitions for different topics the following definitions may be useful (also see *Determining Significance* below.).	**Imperceptible** An effect capable of measurement but without significant consequences
	Not significant An effect which causes noticeable[2] changes in the character of the environment but without significant consequences.
	Slight Effects An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.
	Moderate Effects An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends.
	Significant Effects An effect which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
	Very Significant An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment.
	Profound Effects An effect which obliterates sensitive characteristics.
Describing the Extent and Context of Effects Context can affect the perception of significance. It is important to establish if the effect is unique or, perhaps, commonly or increasingly experienced.	**Extent** Describe the size of the area, the number of sites, and the proportion of a population affected by an effect.
	Context Describe whether the extent, duration, or frequency will conform or contrast with established (baseline) conditions (is it the biggest, longest effect ever?)

[1] Note: the term effects and impacts are used interchangeably in this EIA Report to mean the same thing

Describing the Probability of Effects Descriptions of effects should establish how likely it is that the predicted effects will occur – so that the CA can take a view of the balance of risk over advantage when making a decision.	**Likely Effects** The effects that can reasonably be expected to occur because of the planned project if all mitigation measures are properly implemented.
	Unlikely Effects The effects that can reasonably be expected not to occur because of the planned project if all mitigation measures are properly implemented.
Describing the Duration and Frequency of Effects 'Duration' is a concept that can have different meanings for different topics – in the absence of specific definitions for different topics the following definitions may be useful.	**Momentary Effects** Effects lasting from seconds to minutes
	Brief Effects Effects lasting less than a day
	Temporary Effects Effects lasting less than a year
	Short-term Effects Effects lasting one to seven years.
	Medium-term Effects Effects lasting seven to fifteen years.
	Long-term Effects Effects lasting fifteen to sixty years.
	Permanent Effects Effects lasting over sixty years
	Reversible Effects Effects that can be undone, for example through remediation or restoration
	Frequency of Effects Describe how often the effect will occur. (once, rarely, occasionally, frequently, constantly – or hourly, daily, weekly, monthly, annually)
Describing the Types of Effects	**Indirect Effects (a.k.a. Secondary Effects)** Impacts on the environment, which are not a direct result of the project, often produced away from the project site or because of a complex pathway.
	Cumulative Effects The addition of many minor or significant effects, including effects of other projects, to create larger, more significant effects.
	'Do-Nothing Effects' The environment as it would be in the future should the subject project not be carried out.
	`Worst case' Effects The effects arising from a project in the case where mitigation measures substantially fail.
	Indeterminable Effects When the full consequences of a change in the environment cannot be described.
	Irreversible Effects When the character, distinctiveness, diversity or reproductive capacity of an environment is permanently lost.
	Residual Effects The degree of environmental change that will occur after the proposed mitigation measures have taken effect.
	Synergistic Effects Where the resultant effect is of greater significance than the sum of its constituents, (e.g. combination of SOx and NOx to produce smog).

1 Introduction

1.1 Introduction

Galway County Council on behalf of itself and on behalf of Galway City Council is proposing to develop the N6 Galway City Ring Road (GCRR) around Galway City.

GCC has made a Protected Road Scheme and a Motorway Scheme which are being submitted for approval to An Bord Pleanála (ABP) under Section 49 of the Roads Act 1993, as amended and these Schemes are referred to throughout this report as the proposed road development or the N6 GCRR.

The proposed N6 GCRR, comprises the construction of approximately 6km of a single carriageway from the western side of Bearna Village as far as Ballymoneen Road and approximately 12km of dual carriageway from Ballymoneen Road to the eastern tie-in with the existing N6 at Coolagh, Briarhill, and associated link roads, side roads, junctions and structures, as shown on **Figure 5.1.01** to **5.1.15**. The section of the proposed road development from the tie-in with the R336 Coast Road to the N59 Letteragh Junction will be a protected road[1] and the section from this junction to the tie-in with the existing N6 at Coolagh, Briahill will be a motorway. A full description of the proposed N6 GCRR is provided in **Chapter 5, Description of Proposed Road Development**. A location plan for the proposed N6 GCRR is presented in **Figure 1.1**.

Galway County Council is progressing the proposed N6 GCRR through the statutory process on behalf of itself and Galway City Council under a Section 85 Agreement[2].

The N6 GCRR forms part of, and is identified as a project within the 'Galway Transport Strategy' (GTS). The GTS was prepared by Galway City Council and GCC, in partnership with the National Transport Authority (NTA). The GTS is based on a comprehensive assessment of transport issues facing Galway City and the wider environs and the need to develop a sustainable integrated transport solution to accommodate existing and future travel demand thereby facilitating Galway growing *"in an integrated, sustainable manner that aligns transport investment with settlement patterns, travel movements and also supports a sustainable use of land"* (Galway City Council Development Plan 2017-2023).

The GTS is currently being implemented by Galway City Council, both in terms of the policy objectives established and the delivery of transport projects

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[1] A protected road, means a public road or proposed public road specified to be a protected road in a protected road scheme approved by An Bord Pleanála. A protected road scheme approved by An Bord Pleanála may provide for the prohibition, closure, stopping up, removal, alteration, diversion or restriction of any specified or all means of direct access to the protected road from specified land or from specified land used for a specified purpose or to such land from the protected road.

[2] A Section 85 Agreement has been entered into under the provisions of Section 85 of the Local Government Act 2001 between Galway County Council and Galway City Council and approved by Transport Infrastructure Ireland pursuant to Section 14 of the Roads Act 1993, as amended.

identified within the strategy. Further details on the GTS are available on Galway City Council's website at the link below:
https://www.galwaycity.ie/galway-transport-strategy

This Environmental Impact Assessment Report (EIAR) is defined as "a statement of the effects, if any, which the proposed development, if carried out, would have on the environment" (EPA, 2017). This EIAR details the consideration of alternatives, consideration and assessment of likely significant effects/impacts, mitigation and avoidance measures to reduce significant adverse effects/impacts, and assessment of residual impacts.

This chapter outlines the background to the proposed N6 GCRR and summarises the application procedure for submission of an application for the N6 GCRR. This chapter also describes the methodology used to prepare this EIAR (formerly referred to as an Environmental Impact Statement (EIS)) and the consultation process that has been carried out to date.

1.2 Environmental Impact Assessment Report - Screening, Scoping, Contents and Methodology

1.2.1 Statutory Requirements

This EIAR (formerly referred to as an EIS) has been prepared in accordance with the relevant provisions of Directive 2011/92/EU[3] on the Assessment of the Effects of Certain Public and Private Projects on the Environment as amended by Directive 2014/52/EU[4]. Directive 2014/52/EU amends EIA law in a number of respects by amending Directive 2011/92/EU.

Article 5 and Annex IV to the EIA Directive 2011/52/EU, (as substituted by Directive 2014/52/EU) and Sections 50(2) and 50(3) of the Roads Act 1993, as amended, specify the information to be contained in an EIAR (referred to as an Environmental Impact Statement (EIS) in Roads Act 1993, as amended) in relation to this proposed road development.

Directive 2014/52/EU was required to be transposed by 16 May 2017 and requires changes in Irish laws, regulations and administrative provisions across a number of legislative codes to reflect the contents of Directive 2014/52/EU. At the time of publication of this EIAR, the changes in Irish laws, regulations and administrative provisions across a number of legislative codes (including the Roads Act 1993 as amended and Road Regulations 1994 as amended) have not yet been implemented. However, this EIAR has been prepared in full accordance and compliance with the provisions of Directive 2014/52/EU. Regard has also been had to the current provisions of the relative Irish legislative codes including the Roads Act 1993 as amended as they continue to apply at this time.

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[3] Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (codification).
[4] Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.

Accordingly, this EIAR contains all of the information prescribed by the relevant provisions of the Roads Act, 1993 as amended, the Roads Regulations, 1994 as amended, Article 5 and Annex IV of Directive 2011/92/EU as amended.

Throughout this document, where reference is made to 'environmental impact statement', or 'EIS', it should also be understood to mean 'EIAR'. Likewise, where reference is made to 'EIAR', it should be understood to mean 'environmental impact statement' or 'EIS'.

1.2.2 EIA Screening

The proposed road development exceeds the thresholds set for mandatory Environmental Impact Assessment as specified in Irish legislation. The relevant legislation includes the Roads Act, 1993, as amended and the Roads Regulations, 1994, as amended.

Section 50 (1) (a) of Roads Act, 1993, as amended states the following:

"50(1) (a) A road authority or the Authority shall prepare a statement of the likely effects on the environment ("environmental impact statement") of any proposed road development it proposes consisting of…………

(i) the construction of a motorway,

(ii) the construction of a busway,

(iii) the construction of a service area, or

(iv) any prescribed type of proposed road development consisting of the construction of a proposed public road or the improvement of an existing public road…."

Article 8 of the Roads Regulations, 1994 (*Road development prescribed for the purposes of S. 50(1) (a) of the Roads Act, 1993*) lists the prescribed types of proposed road development which require an EIS (EIAR) as follows:

"8. The prescribed types of proposed road development for the purpose of subsection (1) (a) (iii) of section 50 of the Act shall be—

(a) the construction of a new road of four or more lanes, or the realignment or widening of an existing road so as to provide four or more lanes, where such new, realigned or widened road would be eight kilometres or more in length in a rural area, or 500 metres or more in length in an urban area;

(b) the construction of a new bridge or tunnel which would be 100 metres or more in length"…..

The proposed road development will include approximately 11.9km of dual carriageway and will include a bridge and a viaduct plus two tunnels each of which will be more than 100 metres in length. In addition, the section of the proposed road development from the N59 Letteragh Junction to the tie-in with the existing N6 at Coolagh, Briarhill will be a motorway. Accordingly, the Roads Authority must prepare an EIS (now referred to as an EIAR) for the proposed road development.

Section 2 of the Planning and Development Act 2000, as amended, as inserted by Section 6(c) of the Planning and Development (Strategic Infrastructure) Act, 2006, as amended, defines strategic infrastructure to include all national road development proposals for which an EIS (EIAR) is required. Therefore, all such strategic infrastructure development is dealt with by the Strategic Infrastructure Division of An Bord Pleanála.

1.2.3 Contents of EIAR

This EIAR has been prepared in accordance with the relevant provisions of Directives 2011/92/EU Assessment of the Effects of Certain Public and Private Projects on the Environment as amended by Directive 2014/52/EU and in accordance with the relevant provisions of the Roads Act, 1993, as amended, the Roads Regulation 1993 as amended, Article 5 and Annex IV of Directive 2011/92/EU, as amended.

Article 5 and Annex IV to the EIA Directive 2011/52/EU, (as substituted by Directive 2014/52/EU)[5], and Sections 50(2) and 50(3) of the Roads Act 1993, as amended, specify the information to be contained in an EIAR in relation to this proposed road development.

As discussed previously in **Section 1.2.1**, at the time of publication of this EIAR, the changes in Irish laws, regulations and administrative provisions across a number of legislative codes had not yet been completed in relation to Directive 2014/52/EU. At the time of publication of this EIAR, there are some additional information requirements listed in Article 5 and Annex IV of the EIA Directive, as amended which are currently not listed in Sections 50(2) and 50(3) of the Roads Act 1993, as amended. For example, the Roads Act 1993, as amended, currently refers to an EIS whereas Directive 2014/52/EU now refers to an EIAR.

This EIAR contains all of the information prescribed by the relevant provisions of the Roads Act, 1993 as amended, the Roads Regulations, 1994 as amended and Article 5 and Annex IV of Directive 2011/92/EU as amended by Directive 2014/52/EU.

For clarity on the information to be contained in the EIAR, the relevant sections of the legislation are reproduced below.

Annex IV of the EIA Directive, as amended, specifies the information to be contained in an EIAR and is reproduced in **Table 1.1** below. The information provided in this EIAR meets the requirements for Article 5 and Annex IV to the EIA Directive, as amended.

[5] Annex IV of Directive 2011/92/EU has been replaced in Directive 2014/52/EU

Table 1.1: Annex IV of EIA Directive as amended by Directive 2014/52/EU

ANNEX IV - INFORMATION REFERRED TO IN ARTICLE 5(1) (INFORMATION FOR THE ENVIRONMENTAL IMPACT ASSESSMENT REPORT)
1. Description of the project, including in particular: *(a) a description of the location of the project;* *(b) a description of the physical characteristics of the whole project, including, where relevant, requisite demolition works, and the land-use requirements during the construction and operational phases;* *(c) a description of the main characteristics of the operational phase of the project (in particular any production process), for instance, energy demand and energy used, nature and quantity of the materials and natural resources (including water, land, soil and biodiversity) used;* *(d) an estimate, by type and quantity, of expected residues and emissions (such as water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation) and quantities and types of waste produced during the construction and operation phases.*
2. A description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects.
3. A description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge.
4. A description of the factors specified in Article 3(1) likely to be significantly affected by the project: population, human health, biodiversity (for example fauna and flora), land (for example land take), soil (for example organic matter, erosion, compaction, sealing), water (for example hydromorphological changes, quantity and quality), air, climate (for example greenhouse gas emissions, impacts relevant to adaptation), material assets, cultural heritage, including architectural and archaeological aspects, and landscape.
5. A description of the likely significant effects of the project on the environment resulting from, inter alia: *(a) the construction and existence of the project, including, where relevant, demolition works;* *(b) the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources;* *(c) the emission of pollutants, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste;* *(d) the risks to human health, cultural heritage or the environment (for example due to accidents or disasters);* *(e) the cumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;* *(f) the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change;* *(g) the technologies and the substances used.* *The description of the likely significant effects on the factors specified in Article 3(1) should cover the direct effects and any indirect, secondary, cumulative, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative effects of the project. This description should take into account the environmental protection objectives established at Union or Member State level which are relevant to the project.*
6. A description of the forecasting methods or evidence, used to identify and assess the significant effects on the environment, including details of difficulties (for example technical

ANNEX IV - INFORMATION REFERRED TO IN ARTICLE 5(1) (INFORMATION FOR THE ENVIRONMENTAL IMPACT ASSESSMENT REPORT)
deficiencies or lack of knowledge) encountered compiling the required information and the main uncertainties involved.
7. A description of the measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements (for example the preparation of a post-project analysis). That description should explain the extent, to which significant adverse effects on the environment are avoided, prevented, reduced or offset, and should cover both the construction and operational phases.
8. A description of the expected significant adverse effects of the project on the environment deriving from the vulnerability of the project to risks of major accidents and/or disasters which are relevant to the project concerned. Relevant information available and obtained through risk assessments pursuant to Union legislation such as Directive 2012/18/EU of the European Parliament and of the Council (*)[6]or Council Directive 2009/71/Euratom (**)[7] or relevant assessments carried out pursuant to national legislation may be used for this purpose provided that the requirements of this Directive are met. Where appropriate, this description should include measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies.
9. A non-technical summary of the information provided under points 1 to 8.
10. A reference list detailing the sources used for the descriptions and assessments included in the report.

Sections 50(2) and 50(3) of the Roads Act 1993, as amended, specify the information to be contained in an EIS now referred to as an EIAR. Sections 50(2) and 50(3) of the Roads Act 1993, as amended, are reproduced in **Table 1.2** below. The information provided in this EIAR meets the requirements of Sections 50(2) and 50(3) of the Roads Act 1993, as amended.

Table 1.2: Sections 50(2) and 50(3) of the Roads Act 1993, as amended

SECTIONS 50(2) AND 50(3) OF THE ROADS ACT, 1993, AS AMENDED
"50 (2) An environmental impact statement shall contain the following specified information—
(a) a description of the proposed road development comprising information on the site, design and size of the proposed road development;
(b) a description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects;
(c) the data required to identify and assess the main effects which the proposed road development is likely to have on the environment;
(d) an outline of the main alternatives studied by the road authority concerned and an indication of the main reasons for its choice, taking into account the environmental effects;
(e) a summary in non-technical language of the above information.

[6] (*) Directive 2012/18/EU of the European Parliament and the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (OJ L 197, 24.7.2012, p. 1).
[7] (**) Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations (OJ L 172, 2.7.2009, p. 18)'.

SECTIONS 50(2) AND 50(3) OF THE ROADS ACT, 1993, AS AMENDED
50(3) An environmental impact statement shall, in addition to and by way of explanation or amplification of the specified information referred to in subsection (2), contain further information on the following matters— *(a) (i) a description of the physical characteristics of the whole proposed road development and the land-use requirements during the construction and operational phases,* *(ii) an estimate, by type and quantity, of expected residues and emissions (including water, air and soil pollution, noise, vibration, light, heat and radiation) resulting from the operation of the proposed road development;* *(b) a description of the aspects of the environment likely to be significantly affected by the proposed road development, including in particular—* *—human beings, fauna and flora,* *—soil, water, air, climatic factors and the landscape,* *—material assets, including the architectural and archaeological heritage, and the cultural heritage,* *—the inter-relationship between the above factors;* *(c) a description of the likely significant effects (including direct, indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative) of the proposed road development on the environment resulting from—* *—the existence of the proposed road development,* *—the use of natural resources,* *—the emission of pollutants, the creation of nuisances and the elimination of waste,* *and a description of the forecasting methods used to assess the effects on the environment;* *(d) an indication of any difficulties (technical deficiencies or lack of know-how) encountered by the road authority concerned in compiling the required information;* *(e) a summary in non-technical language of the above information;* *to the extent that such information is relevant to a given stage of the consent procedure and to the specific characteristics of the proposed road development or type of proposed road development concerned, and of the environmental features likely to be affected, and the road authority preparing the environmental impact statement may reasonably be required to compile such information having regard, inter alia, to current knowledge and methods of assessment.";*

1.2.4 Structure of EIAR

This EIAR has been prepared by Arup comprising their team of in-house competent experts and external competent experts on behalf of TII, Galway County Council and Galway City Council. Refer to the List of Contributors for further details on the competent experts. Input has also been provided to the EIAR, where necessary from TII, Galway County Council and Galway City Council.

The EIAR comprises four volumes of which this is the second. The four are as follows:

- Volume 1 – Non-Technical Summary
- Volume 2 – Environmental Impact Assessment Report (Main Text)
- Volume 3 – Figures
- Volume 4 – Appendices

The main text of the EIAR has been further divided into the following chapters:

- Chapter 1 – *Introduction*
- Chapter 2 – *Planning and Policy Context*
- Chapter 3 – *Need for the Proposed Road Development*
- Chapter 4 – *Alternatives Considered*
- Chapter 5 – *Description of the Proposed Road Development*
- Chapter 6 – *Traffic Assessment and Route Cross-Section*
- Chapter 7 – *Construction Activities*
- Chapter 8 – *Biodiversity*
- Chapter 9 – *Soils and Geology*
- Chapter 10 – *Hydrogeology*
- Chapter 11 – *Hydrology*
- Chapter 12 – *Landscape and Visual*
- Chapter 13 – *Archaeology, Architectural and Cultural Heritage*
- Chapter 14 – *Material Assets Agriculture*
- Chapter 15 – *Material Assets Non-Agriculture*
- Chapter 16 – *Air Quality and Climate*
- Chapter 17 – *Noise and Vibration*
- Chapter 18 – *Human Beings, Population and Human Health*
- Chapter 19 – Major Accidents, *Inter-relationships, Interactions and Cumulative Impacts*
- Chapter 20 – *Summary of Residual Impacts and Mitigation Measures*
- Chapter 21 – *Schedule of Environmental Commitments*

The format which has been used in this EIAR is the grouped format, in which each topic is addressed in a separate section. This is designed to allow readers to access the issues of interest to them as easily as possible. However, there is an overlap of some topics. For example, effects on human beings are addressed in a number of chapters including **Chapter 12, Landscape & Visual**, **Chapter 15, Material Assets Non-Agriculture, Chapter 16, Air Quality and Climate,** and **Chapter 17, Noise and Vibration**, as well as **Chapter 18, Human Beings, Population and Human Health**. Effects on land are addressed in a number of chapters including: **Chapter 14, Material Assets Agriculture, Chapter 15, Material Assets Non-Agriculture, Chapter 12, Landscape & Visual**, as well as **Chapter 18, Human Beings, Population and Human Health**. It should be noted that the term effects and impacts are used interchangeably in this EIAR to mean the same thing.

Significant effects on environmental topics arising from the vulnerability of the proposed road development to risks of major accidents and/or disasters are addressed in **Chapter 19, Major Accidents, Inter-Relationships, Interactions and Cumulative Impacts**.

Issues not directly addressed in individual chapters and interactions between environmental issues will be described in **Chapter 19, Major Accidents, Inter-Relationships, Interactions and Cumulative Impacts**. Alternatives considered and a description of the proposed road development are presented in **Chapters 4,** and **5** respectively.

As noted in **Section 1.1**, the N6 GCRR forms part of, and is identified as a project within the 'Galway Transport Strategy' (GTS). However, the implementation of the proposed road development is not reliant on the delivery of other components of the GTS. It is a stand-alone development. Therefore, the EIA process for the proposed road development is a stand-alone process. However, the implementation of some objectives of the GTS are reliant on the delivery of the proposed road development. Therefore, where relevant the cumulative impacts of other proposals within the GTS have been included in this EIAR.

In addition, a Natura Impact Statement has been submitted with the application to An Bord Pleanála for approval so as to inform the Appropriate Assessment (AA) process and to assist An Bord Pleanála in carrying out the AA required pursuant to the Planning and Development Act, 2000 (as amended) and the Habitats Directive.

1.2.5 Details of Competent Experts

This EIAR has been compiled by Arup on behalf of GCC with assessment and reporting provided by competent experts for each individual topic. The main author and details of the expertise of each competent expert are provided below in **Table 1.3**.

Table 1.3: Details of Competent Experts

Topic	Main Author – Competency Details
Chapter 1 **Introduction**	**Eileen McCarthy BE (Hons) MIEI CEng, MICE CEng, PE (USA), Arup** **Eileen McCarthy** is an Associate Director with Arup. She holds an honours degree in Civil Engineering from University College Cork and is a Chartered member of the Institute of Civil Engineers in London, a Chartered Member of Engineers Ireland and a licensed professional engineer in USA. Eileen has 30 years' relevant experience and in particular, managed the planning and design for various road schemes including M7 Osberstown Interchange and R407 Sallins Bypass Scheme, M20 Cork – Limerick Motorway Scheme, M7/N24 Ballysimon Road Improvement Scheme, N22 Baile Bhuirne to Macroom Scheme and the Naas Southern Ring Road in Kildare. She has been directly responsible for the project management of the N6 Galway City Ring Road since commencement of work on this application to An Bórd Pleanála in December 2013 and has been assisted as required by members of the design team in compiling this EIAR. Eileen McCarthy supervised the preparation of Chapter 1 of the EIAR.
Chapter 2 **Planning and Policy Context**	**Pauline Byrne MRUP BSc, Brady Shipman Martin – Planning** **Pauline Byrne** is a Regional and Urban Planner with over 18 years' experience in planning in Ireland and internationally. Pauline has a Masters in Regional and Urban Planning (MRUP) from University College Dublin, and a B.Sc. (Mgmt.) from Trinity College Dublin. Pauline is a Partner at Brady Shipman Martin and is head of the Planning Team in the Practice. Pauline has worked on urban planning strategies, planning policy, major city development initiatives, large scale infrastructure projects, public transport initiatives, industrial development initiatives, and arbitration cases, on behalf of Government departments and agencies, Local Authorities, State bodies and State companies, including NTA, OPW, ESB, Bord Na Mona, and the private sector. Pauline has previously inputted to environmental impact assessments in relation to Strategic Planning Policy Context on bus network planning in Dublin for the NTA. Pauline Byrne prepared Chapter 2 of the EIAR with assistance from Eileen McCarthy Arup.
Chapter 3 **Need for the Proposed Road Development**	**Eileen McCarthy BE (Hons) MIEI CEng, MICE CEng, PE (USA), Arup** See above Eileen McCarthy supervised the preparation of Chapter 3 of the EIAR.
Chapter 4 **Alternatives Considered**	**Eileen McCarthy BE (Hons) MIEI CEng, MICE CEng, PE (USA), Arup** See above Eileen McCarthy supervised the preparation of Chapter 4 of the EIAR.

Topic	Main Author – Competency Details
Chapter 5 **Description of Proposed Road Development**	**Eileen McCarthy BE (Hons) MIEI CEng, MICE CEng, PE (USA), Arup** See above Eileen McCarthy supervised the preparation of Chapter 5 of the EIAR.
Chapter 6 **Traffic Assessment and Route Cross Section**	**Andrew Archer, Systra - Traffic** **Andrew Archer** is a Chartered Engineer and Project Director for Systra's operation in Ireland, with over 16 years of diverse and challenging experience in a wide range of transportation planning, policy and engineering projects. Through his work in Europe and the Middle East, Andrew has played a major role in strategic planning and innovative design on a number of key public and private sector transportation projects including land use and transportation studies, development masterplans, transport framework plans, highway scheme appraisal, and conceptual designs of transport infrastructure schemes. Andrew's particular expertise lies in working with clients and stakeholders in a collaborative manner to develop practical and implementable strategies for large scale towns, urban regeneration projects or individual developments. Andrew has also managed and delivered a range of multi-modal transport studies across Ireland, including integrated land use and transportation framework plans, local area plans, traffic management strategies, road safety designs, school traffic management strategies and parking management schemes. **David Conlon, Systra - Traffic** **David Conlon** is an experienced Principal Transport Planning Consultant with 10 years' experience. David joined SYSTRA on the Graduate Development Programme after a short period working with ILTP Consultants. David has a specialist knowledge in the preparation of transport models at a strategic and local level as well as project appraisal. With SYSTRA David has experience of a number of challenging model development projects and was project manager for the development of the National Transport Authority's South East Regional Model (SERM). As Project Manager, David was responsible for the delivery of all aspects of the project including scoping, resourcing, overseeing the technical aspects of the model development, reviewing and issuing reports. David has also performed economic assessments of modelled options using TUBA and has a working knowledge of a wide variety of transportation software that includes SATURN, VISSIM, Paramics, OmniTrans and ArcGIS. Andrew Archer prepared Chapter 6 of the EIAR with assistance from David Conlon.
Chapter 7 **Construction Activities**	**Eileen McCarthy BE (Hons) MIEI CEng, MICE CEng, PE (USA), Arup- General Construction Activities** See above **Janet Lynch BEng, MCTWM, MIEI CEng, Arup - Waste** **Janet Lynch** is a Senior Project Engineer with Arup with over 17 years' experience in Industrial Emissions licensing, EIA and planning including, Resource and Waste Management: Construction and operational waste management plans, Energy from Waste, waste re-use,

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	recycling and landfill, Innovative waste treatment technologies; Planning and EIA project management (energy, renewables, industrial, infrastructure); Industrial Emissions (IE) License applications & review (waste, biomass, oil and gas, energy, cement, pharmaceutical); Circular Economy; Water: Tender Assessments for Irish Water and Dublin City Council; Assistant Project Manager for the expansion of Irelands largest water treatment plant at Ballymore Eustace, Co. Kildare in 2006. Janet holds an honours degree in Civil and Environmental Engineering from University College Cork, a FETAC Certificate in Waste Facility Management and a Certificate in Applied Project Management from the IEI and University Limerick. She is a Chartered member of the Chartered Institution of Wastes Management (MCTWM) and a Chartered Member of Engineers Ireland. Janet Lynch prepared the waste section of Chapter 7 of the EIAR. Eileen McCarthy supervised the overall preparation of Chapter 7 of the EIAR.
Chapter 8 Biodiversity	**Aebhín Cawley CEnv MCIEEM, Scott Cawley - Biodiversity** **Aebhín Cawley** is a director of Scott Cawley Ltd. She holds a degree in Zoology from the University of Dublin (Trinity College) and also holds a postgraduate diploma in Physical Planning from the same university. She is a Chartered Environmentalist (CEnv) with the Society for the Environment (Soc Env) and a full member of the Chartered Institute of Ecology and Environmental Management (CIEEM). Aebhín has sixteen years' professional experience, twelve of which have been in ecological surveying and impact assessment for public and private sector projects including road, rail and other major infrastructural projects. Aebhín has been undertaking Appropriate Assessment (AA) work in Ireland since 2002 and has been influential in determining the direction in which AA work is evolving in Ireland. She has delivered lectures and training on AA to a range of public and private sector organisations, including a range of planning authorities, as well as professional institutes. Aebhín regularly prepares AA Screening Statements as well as Natura Impact Statements (NIS) for AA and as such has current experience in best practise in undertaking Appropriate Assessments. Aebhín was the project director for the Biodiversity chapter of the EIAR and the NIS with overall responsibility for the delivery of those reports as well as for high-level input to the survey methodologies, assessment of impacts and development of the mitigation strategy. Aebhín also undertook specific elements of the field survey work. **Andrew Speer MCIEEM, Scott Cawley - Biodiversity** **Andrew Speer** is a principal ecologist at Scott Cawley and specialises in road projects. He holds an honours degree in Zoology from the National University of Ireland, Galway and a post-graduate diploma in Geographic Information Systems (GIS). He is a full member of the Chartered Institute of Ecology and Environmental Management (CIEEM). Andrew has over 11 years' experience as an ecological consultant with experience in Environmental Impact Assessment, GIS and mitigation design for development projects including national road schemes, wind energy projects, light rail, flood relief schemes, infrastructure projects and smaller scale commercial and residential developments. He has comprehensive experience in the preparation of AA Screening Reports and NISs for a range of projects and development plans. Andrew has undertaken and managed a wide range of field surveys including protected species surveys (e.g. badger, otter, newts, bats, wintering birds, breeding birds and aquatic species), habitat surveys and water quality monitoring. He is also an experienced ecological clerk of works for projects such as national road schemes, pipeline works and electricity supply schemes. Andrew has extensive GIS experience on both the

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	ArcGIS and Autodesk Map 3D platforms. Andrew was lead ecologist for the Biodiversity chapter of the EIAR and the NIS. He undertook and managed field and desk surveys, carried out the impact assessments and devised the mitigation strategy for flora and fauna on the project. **Paul Scott, Scott Cawley CEcol, CEnv, MIEEM - Biodiversity** **Paul Scott** is Director with Scott Cawley. He holds a first class honours degree in Environmental Biology from the University of Liverpool and a Masters in Pollution and Environmental Control from the University of Manchester. Paul is a Chartered Ecologist (CEcol), a Chartered Environmentalist (CEnv) and a full member of the Chartered Institute of Ecology and Environmental Management (CIEEM). He is on the Council of Bat Conservation Ireland, leads the Dublin Bat Group and All Ireland Nathusius Pipistrelle Working Group and is a licenced and trained bat handler with experience of hand-netting, harp trapping and mist netting of bats in Ireland and the UK. Paul is experienced in the assessment of impacts of major infrastructural developments on all Irish bat species. Paul has prepared ecological guidance notes designed for planners and developers on behalf of the four Dublin local authorities, including advice on compliance with legal protection for bats. Paul undertook specific elements of the field survey work (including bats) and prepared the text relating to bats in the EIAR. Andrew Speer was responsible for the preparation of Chapter 8 of the EIAR under the supervision of Aebhín Cawley with the exception of bats which was prepared by Paul Scott.
Chapter 9 **Soils and Geology**	**Juli Crowley BE MSc Eng MIEI CEng, Arup – Soils and Geology** **Juli Crowley** is a Senior Geotechnical Engineer with Arup with over 12 years of engineering experience. She holds a Structural Engineering Degree from Cork Institute of Technology, a Masters in Geotechnical Engineering from Newcastle University and is a Chartered Engineer with Engineers Ireland since 2011. Juli has worked on a broad range of infrastructure, commercial, private and oil and gas projects at pre-tender stage, detailed design stage and post construction stage and has extensive geotechnical design and construction experience. Juli has prepared the soils and geology impact assessments for projects including the M20 Cork to Limerick Motorway. Juli Crowley prepared Chapter 9 of the EIAR.
Chapter 10 **Hydrogeology**	**Dr. Leslie Brown PhD MSc BSc, Arup - Hydrogeology** **Dr. Leslie Brown** is a senior hydrogeologist with 21-years groundwater expertise in Ireland, the United Kingdom and Middle East. As an academic Dr. Brown’s doctoral studies include delineating extents of groundwater bodies in karst aquifers, mapping surface and subsurface paleokarst features, quantifying karst flow pathways and limestone geology. He has undertaken post-doctoral research into quantifying recharge mechanisms and identification of hydrogeological pathways for catchment studies. As a consultant Leslie has worked with both the public and private sectors advising on hydrogeological matters for road developments, groundwater supply, turlough hydrogeology, determining zones of contribution to groundwater dependant terrestrial ecosystems and aquifer management. He has specialised on the hydrogeology of linear infrastructure since 2000 and is a co-author for the NRA (2009) Guidelines on Procedures for Assessment and treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

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	Dr. Alison Orr PhD MSc BSc, Arup - Hydrogeology **Dr. Alison Orr** is a hydrogeologist with 3 years' experience working in consultancy on projects in both Ireland and the UK. She has worked on road and metro developments, flood relief schemes, contaminated land, groundwater supply, ground source heating systems and determining zones of contribution for group water schemes. Prior to her consultancy work she completed a PhD into the fate and transport of nitrate in different hydrogeological settings across the island of Ireland. Dr Brown prepared Chapter 10 of the EIAR with the assistance of Dr. Orr.
Chapter 11 Hydrology	**Tony Cawley BE M Eng Sc CEng MIEI, Hydro Ltd – Hydrology** **Anthony Cawley** qualified with an honours degree in Civil Engineering from NUI Galway in 1987 and a post graduate master's degree in Engineering Hydrology from NUI Galway in 1990. He is a Chartered Civil Engineer with specialist education and 28 years professional consulting experience in the water engineering field in a wide variety of activities relating to hydrology, hydrogeology and flooding, and hydrodynamic and hydraulic assessment of fluvial and tidal processes. Over that period he has been involved in well over 200 flooding and coastal modelling assessments. Tony has carried out in excess of 100 flood risk assessment studies on rivers, estuaries and coastal areas throughout Ireland. These studies ranged from scoping type assessments to detailed flood risk assessments involving hydrometric measurements river channel survey, hydraulic modelling and flood inundation mapping. Tony has successfully completed and defended at the oral hearing giving expert witness on the hydrology, hydrogeology, geology and soils components of the EIA assessment for numerous road schemes and infrastructure projects over the past 15 years including the M6, M20/M21, N23 and Lansdowne Stadium Redevelopment. He has also been retained as an expert consultant to An Bord Pleanála for the Dublin Docks Gateway and Alexandra Basin projects in respect to flooding and hydrodynamic processes and is experienced in the requirements of SEA and AA. Tony has been a Hydrology Expert on behalf of ESB involved in Court proceedings in respect to the River Lee Flooding of Cork City in November 2009 UCC v's ESB. He was a lecturer in hydrology and hydraulics at the Hydrology and Civil Engineering Department at NUI Galway and currently lectures in Hydrology at the University of Limerick (2011 to date). Tony has provided training courses in Hydrology to the Western and Northwestern Fisheries Board and to Engineers Ireland, and Irish Rail and NRDO Design Offices. Tony Cawley prepared Chapter 11 of the EIAR.
Chapter 12 Landscape and Visual	**Thomas Burns B Agr. Sc. Dip. EIA Mgmt MILI EFLA. Brady Shipman Martin – Landscape and Visual** **Thomas Burns** is a Partner and landscape planner with Brady Shipman Martin. Thomas joined Brady Shipman Martin as a Landscape Architect after graduating from University College Dublin, in 1989. Thomas completed a post-graduate Diploma in Environmental Impact Assessment Management also in University College Dublin, in 1994 and was appointed an Associate of the Practice in 1997. Thomas became a Partner in 2002.

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	Thomas has a strong background in environmental, landscape and planning issues across a wide range of disciplines, including assessment and master-planning. For over 20 years, Thomas has been involved in the masterplanning, planning, environmental assessment and construction of a diverse range of projects, and as part of his involvement, has regularly given expert evidence at planning hearings and other public inquiries. Thomas has been directly involved in the environmental and landscape and visual assessments of many key national infrastructure projects, including over 750km of the national roads programme including the M20 Cork to Limerick Motorway Scheme, the M7 Osberstown Interchange and R407 Sallins Bypass, the Shannon LNG Facility, the Corrib Gas Terminal, T2 Terminal at Dublin Airport and the Dublin DART Underground project. Given his experience on National Roads, Thomas was commissioned by the TII to raft Guidelines for Landscape Treatments on National Roads in Ireland. He has also brought his environmental and landscape planning experience to projects such as the Strategic Environmental Assessment aspect of various statutory plans and programmes, including County Meath Development Plan 2013-2019; the Department of Environment IOSEA 5 and as well being part of the wider project team that carried out the Environmental Assessment of Food Harvest 2020. Thomas is an active member of the Irish Landscape Institute (ILI), where he was Chairperson of the Professional Practice Committee since its inception in 1995 until 2011. Thomas also previously served as the ILI Representative on the Council of the European Foundation of Landscape Architecture (EFLA) from 1997 to 2000. Thomas Burns prepared Chapter 12 of the EIAR.
Chapter 13 Archaeology, Architectural and Cultural Heritage	**Faith Bailey MA BA MCIfA, IAC Archaeology – Archaeology, Architectural and Cultural Heritage** **Faith Bailey** is a Senior Archaeologist and Cultural Heritage Consultant with IAC Ltd. She holds an MA in Cultural Landscape Management (archaeology and built heritage) and a BA in single honours archaeology from the University of Wales, Lampeter. Faith is a licence eligible archaeologist, a member of the CIfA and has over 13 years' experience in the sector. Faith has been responsible for the production and delivery of a large number of archaeological and built heritage desk top assessments, surveys, EIA, master plans, LAP/SEA and management plans associated with all sectors of development in the Republic and Northern Ireland. Archaeological and Architectural EIA for large scale road schemes, include the M7 Osberstown Interchange and R407 Sallins Bypass Scheme, the M11 Enniscorthy Bypass in County Wexford and the N22 Ballyvourney-Macroom Bypass in County Cork. Faith's in-depth knowledge of the planning systems and heritage legislation within both the Republic of Ireland and Northern Ireland, twinned with the excellent working relationship with clients and statutory authorities makes her one of the most experienced archaeological and cultural heritage consultants currently operating within the sector. Faith Bailey prepared Chapter 13 of the EIAR.

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Chapter 14 Material Assets Agriculture	**Con Curtin, Curtin Agricultural Consultants Ltd – Material Assets Agriculture** **Con Curtin** is an agricultural consultant with an undergraduate honours degree in Agricultural Science from University College Dublin (1987), a Level 6 Certificate in Agricultural Land Drainage (awarded by Teagasc in 2016) and has 30 years' experience working in the agricultural consultancy sector. He has worked for three years with ADAS (Agricultural Development and Advisory Service) in the UK as an agricultural advisor, and since 1990 as an agricultural consultant in Ireland. In 1996 he established his own company, Curtin Agricultural Advisers Ltd. Con divides his time between general consultancy work for his farmer clients (dairy, pigs, beef, sheep and equine) and Land Use / Agricultural Environmental Impact Reports for consulting engineers. Con has prepared Land Use / Agricultural Impact Reports for linear developments such as railway schemes, electricity overhead lines and major roads schemes (15 No. since 1998) including; M20 Cork to Limerick Motorway Scheme (80km); N22 Baile Bhuirne to Macroom (25km); M7 Castletown to Nenagh (40km); N25 New Ross Bypass (13.5km); N25 Waterford Bypass (40km); and N6 Galway City Outer Bypass (21km – 2006 planning application). He has prepared constraints and route selection reports and presented oral evidence at public hearings for most of these road projects. He has prepared the Land Use Impact Report for the North - South 400kV Interconnection Development (140km) in Counties Meath, Cavan, Monaghan, Armagh and Tyrone. Con has carried out land damage assessments for Bord Gais along gas pipelines in Northern Ireland and the Republic of Ireland and advises on drainage issues. **Michael Sadlier, EVC - Equine** **Michael Sadlier** graduated as a veterinary surgeon from University College Dublin in 1983. Since then, he has worked in veterinary practice around the world, specialising in equine medicine and surgery. He has also achieved numerous post graduate qualifications – a certificate in Equine Stud Medicine from the Royal College of Veterinary Surgeons in 1989, membership by examination of the Australian College of Veterinary Scientists in Equine Surgery in 1992 and achieved a Certificate in Equine Surgery from the Royal College of Veterinary Surgeon in Equine Orthopaedic in 1995. He is currently a Partner in a Six Partner Multi-Site Veterinary Hospital on the Curragh, Co. Kildare that employs another 13 veterinary surgeons and 22 support staff. The practice provides a referral facility for the whole of Ireland and is a world recognised centre of excellence. He is currently an elected member of the Veterinary Council of Ireland, which is the statutory regulatory body for the profession in Ireland. He has been the Irish representative on the National Council of the British Equine Veterinary Association for the past 8 years. Michael was a Past Chairman of the Equine Committee of Veterinary Ireland, the representative body for the profession in Ireland. He also has served on the Board of Directors of Veterinary Ireland and on the Board of Governors of the Irish Equine Centre. He is a regular speaker at veterinary meetings, nationally and internationally. Michael Sadlier has provided expert equine veterinary opinion to TII on the potential effects the following road schemes (M8, M17, N4, N11, N18, N22 N30, N60 and N61) would have on selected equine properties. He has also provided expert equine veterinary opinion to Iarnrod Eireann on the proposed Navan to Dunboyne Rail development, Bord Gais on Baunlusk to Great Island Gas Pipeline and Eirgrid on the North-South Interconnector and Cork-Kildare 400kV Line and the potential impacts these schemes would have had on numerous equine properties on

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	the proposed routes. He has also assessed the effects the proposed incinerator at College Proteins in Nobber, Co. Meath would have on surrounding equine holdings. Con Curtin prepared Chapter 14 of the EIAR with assistance from Michael Sadlier.
Chapter 15 Material Assets Non Agriculture	**Eileen McCarthy BE (Hons) MIEI CEng, MICE CEng, PE (USA), Arup – private dwellings** See above **Dr. Craig Bullock**, **Optimize Consultant – Commercial Properties** **Dr. Craig Bullock** has a PhD in Environmental and Resource Economics (UCD, 2004) and a Diploma in Environmental Impact Assessment (UCD, 2001). He has written over 40 peer-reviewed papers in environmental policy/economics and socio-economics. Craig has over 17 years' experience working in the field of environmental impact assessment (Human Beings and Social/Socio-Economic assessment) and over 20 years in the fields of environmental policy analysis, environmental economics and socio-economics. He manages his own consultancy www.optimize.ie which was registered in 1999 and has also been a part-time research fellow in University College Dublin since 2001. During this time Craig has worked on over 30 environmental impact assessments of road projects, public transport, flood mitigation, waste water treatment, peat extraction, residential and hotel development. This experience has included large scale projects such as the DART Underground development, Swords-City Centre Bus Rapid Transit and the M20 motorway scheme. He has acted as specialist witness for many of these projects. **Gareth Maguire BSc. MRIAI, RIBA, BDP – University Masterplanner** **Gareth Maguire** is an Architect Director with BDP in Dublin. BDP are a large multi-disciplinary practice with over 700 professionals across the globe. BDP are working in third level campuses across Ireland on various major development projects. He leads the BDP Architects group in Ireland. Gareth has over 25 years' experience of working as an Architect and Master planner across Ireland and the UK. Gareth holds a first class honours degree in Architecture from Queens University Belfast, a Post graduate diploma in project management from Trinity College Dublin and a masters in Architecture from Glasgow School Art, University of Glasgow. He is a Chartered Member of the Royal Institute of Architects in Ireland (MRIAI) and a member of the Royal Institute of British Architects (RIBA), Gareth is an architect and urbanist who specialises in campus masterplanning. He has completed a number of major campus master plans recently for Maynooth University, Limerick Institute of Technology and also Haulbowline Island along with the Irish Maritime Cluster in Ringaskiddy, Cork. In the past he has also been involved with the University of Limerick campus 2020 Masterplan proposals for the expansion of their campus across the River Shannon into County Clare. This is now one of the largest university sports campus' in Ireland.

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	He also sits with Maynooth University and LIT's Capital Development Advisory Committees advising on the appropriate development and integration of numerous live projects within their campuses. He is currently designing a major new sports campus for Maynooth University as part of their immediate future campus expansion programme. His various projects currently include a major masterplan and public realm upgrade for the upgrading of Clanbrassil Street in Dundalk, Haulbowline Island Visioning Masterplan and proposals for Waterford Institute of Technology's Carriganore Sports and Technology Campus. **Michael Saddlier – Equine** See above Eileen McCarthy supervised the preparation of Chapter 15 of the EIAR with assistance of Dr. Craig Bullock for the assessment of commercial properties, Gareth Maguire in relation to NUIG Sporting Campus and Michael Saddlier for Galway Racecourse.
Chapter 16 **Air Quality and Climate**	**Sinead Whyte MSc CMIWEM, Arup – Air Quality and Climate** **Sinead Whyte** has over 18 years' experience as an Environmental Consultant. She holds a MSc in Experimental Physics and is Chartered for over 10 years with the Institute of Water and Environmental Management. She has prepared numerous Air Quality and Climate Impact Assessments for infrastructural developments including DART Underground, M20 Cork to Limerick Motorway, M7 Osberstown Interchange and R407 Sallins Bypass and N9/N10 Kilcullen to Powerstown. Sinead presented expert witness evidence at the An Bord Pleanála oral hearings into these developments. Sinead Whyte prepared Chapter 16 of the EIAR.
Chapter 17 **Noise and Vibration**	**Jennifer Harmon BSc- AWN Consulting Limited – Noise and Vibration** **Jennifer Harmon** is Senior Acoustic Consultant at AWN Consulting. She has worked as a consultant since 2000, specialising in acoustics since 2001. She holds a BSc in Environmental Science, a Diploma in Acoustics and Noise Control and is a full member of the Institute of Acoustics (IOA). Jennifer has extensive experience in the field of environmental noise and vibration impact assessment, noise control engineering, building and room acoustics. Jennifer has prepared noise and vibration impact assessments for a wide range of transport projects across Ireland including new road schemes, road realignment and upgrade projects, light and heavy rail projects and landside air-noise. Her experience in road traffic noise impact assessment includes extensive baseline studies, detailed transport noise models, noise mitigation design and construction impact assessments. Jennifer Harmon prepared Chapter 17 of the EIAR.

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Chapter 18 Human Beings, Population and Human Health	**Dr. Craig Bullock, Optimize Consultant - Socio-Economic Assessment** See above **Health assessment** **Dr. Martin Hogan, EHA Occupation Health Hygiene Consultants – Health** **Dr. Martin Hogan** is a medical doctor, registered with the Irish Medical Council as a Specialist in Occupational Medicine since 1997. He has 20 years' experience in assessing Human Health impacts of proposed developments and has contributed to many Environmental Impact Statements. He has given evidence in over 20 Oral Hearings including transport infrastructure such as road, rail and airport development, as well as waste management including landfills and incinerators. His specialist interests include Occupational Medicine in the Pharmaceutical and Chemical industry and Environmental Medicine. He lectures in Toxicology in University College Cork. He is a past National Speciality Director of Occupational Medicine in Ireland and a past Dean of the Faculty of Occupational Medicine of the Royal College of Physicians of Ireland. He is the President of the Organising Committee for ICOH 2018 and a member of the Board of ICOH (International Commission on Occupational Health). **John Cronin BA, John Cronin & Associates – Irish Language** **John Cronin** is a cultural heritage and conservation consultant with 24 years' postgraduate experience garnered in the public and private sectors. He holds a B.A. in Archaeology and Geography from University College Cork and was awarded postgraduate degrees in planning and conservation from University College Dublin. Since entering private practice in 2000, Mr. Cronin has specialised in assessing the impact of development on cultural heritage resources and has acted as consultant to The Heritage Council, the National Inventory of Architectural Heritage and Fáilte Ireland. Mr. Cronin has prepared cultural heritage assessments for environmental impact assessments throughout Ireland (both within Northern Ireland and the Republic of Ireland). Since 2006, John Cronin & Associates have prepared language impact assessments for numerous development projects within Gaeltacht areas. Noteworthy assessments have included: • N59 Maigh Cuilinn (Moycullen) Bypass Road Development, County Galway • N6 Galway City Outer Bypass 2006, County Galway • Housing Development, Ballynabooly, Dingle, County Kerry • Tourism Development, Cloghan Lodge, Ballybofey, County Donegal • Residential development, Rathkieran, The Glen, Ballinskelligs, County Kerry Dr. Craig Bullock and Dr. Martin Hogan with assistance from John Cronin on the Irish Language both prepared Chapter 18 of the EIAR.

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Chapter 19 Major Accidents, Inter-relationships, Interactions and Cumulative Impacts	**Eileen McCarthy BE (Hons) MIEI CEng, MICE CEng, PE (USA), Arup** See above Eileen McCarthy supervised the preparation of Chapter 19 of the EIAR.
Chapter 20 Summary of Mitigation Measures and Residual Impacts	**Eileen McCarthy BE (Hons) MIEI CEng, MICE CEng, PE (USA), Arup** See above Eileen McCarthy supervised the preparation of Chapter 20 of the EIAR.
Chapter 21 Schedule of Environmental Commitments	**Eileen McCarthy BE (Hons) MIEI CEng, MICE CEng, PE (USA), Arup** See above Eileen McCarthy supervised the preparation of Chapter 21 of the EIAR.

1.2.6 EIAR Scoping

"Scoping" is a process of deciding what information should be contained in an EIAR (EIS) and what methods should be used to gather and assess that information[8]. Informal EIAR (EIS) scoping of N6 Galway City Ring Road (GCRR) was carried out in order to determine the content and extent of the matters which should be covered in the environmental information to be included in the EIAR. As part of the EIAR scoping process, a scoping report was issued to all relevant statutory and non-statutory consultees. These consultees are included in **Section 1.4** of this report. Comments received during this consultation phase were reviewed and considered in the preparation of this document.

1.2.7 EPA Guidelines and other guidelines

This EIAR has been prepared with due regard to the guidelines on the preparation of environmental impact assessment reports published by the EPA. These are contained in:

- Guidelines on the information to be contained in Environmental Impact Statements, 2002, EPA
- Advice Notes on Current Practice (in preparation of Environmental Impact Statements), 2003, EPA

Moreover, the EIAR has been prepared having had due regard to:

- Draft Guidelines of the information to be contained in Environmental Impact Assessment Reports, 2017, EPA
- Revised Guidelines on the Information to be Contained in Environmental Impact Statements (Environmental Protection Agency, draft September 2015)
- Advice Notes for Preparing Environmental Impact Statements Draft September 2015
- European Union (2013) Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment
- European Commission (2017) Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU
- European Commission (2012) Interpretation suggested by the Commission as regards the application of the EIA Directive to ancillary/associated works
- European Commission (2006) Clarification of the application of Article 2(3) of the EIA Directive
- European Commission (1999) Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions
- Transport Infrastructure Ireland (formerly National Roads Authority) (2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide

[8] EPA 2015 Revised Guidelines on the information to be contained in EISs, Draft Sept 2015.

1.3 Background

This section provides some background to the proposed road development. **Section 1.3.1** gives an overview of the N6 Galway City Outer Bypass which was an earlier project for a bypass of Galway City that went through the planning process in 2006. **Section 1.3.2** outlines the development of the transport solution to address the very serious traffic issues facing Galway City and the Galway Transport Strategy (GTS).

1.3.1 N6 Galway City Outer Bypass

The N6 Galway City Outer Bypass, an earlier scheme, was previously developed and submitted to An Bord Pleanála (ABP) for approval on 1 December 2006. A brief summary of its history is outlined below.

Consultants were appointed in 1999 to undertake feasibility studies, route selection, design and planning for the N6 Galway City Outer Bypass. The resultant scheme including the Compulsory Purchase Order (CPO) and Environmental Impact Statement (EIS) was submitted to An Bord Pleanála (ABP) on 1 December 2006. This scheme consisted of 21.4km of mainline, 9km of link roads, associated junctions and a major bridge crossing of the River Corrib. This scheme is referenced as the N6 Galway City Outer Bypass (2006) together with the acronym of 2006 GCOB throughout this report.

On 28 November 2008, ABP delivered its decision in respect of the 2006 GCOB. ABP considered that the need for an outer bypass of Galway City connecting the existing N6 on the east to the R336 Coast Road on the west as an essential part of the strategic transport network of the Galway area had been established.

ABP granted approval for the eastern part of the scheme, the section from the N59 Moycullen Road east to the existing N6, inclusive of both junctions at the N59 Moycullen Road and the existing N6. In its decision, ABP noted its consideration of all data presented and granted approval as it considered that the part of the road development being approved would be an appropriate solution to the identified traffic needs of the city and surrounding area. ABP noted that there would be a localised severe impact on the Lough Corrib candidate Special Area of Conservation (cSAC) [9].

However, given that a section of the proposed road development would cut through Tonabrocky Bog which is:

- part of the Moycullen Bogs Natural Heritage Area (NHA)
- an active Blanket bog listed as a priority habitat in Annex I of the EU Habitats Directive
- the site of a population of Slender cotton grass which is a legally protected and vulnerable species

ABP was not satisfied that this part of the proposed road development, between the N59 Moycullen Road and R336 Coast Road, would not be prejudicial to the preservation of the Tonabrocky bog habitat or that the significant adverse effects

[9] Reference ABP decision 07.ER.2056

on the environment would not be avoidable or could not be better addressed by an alternative route[10], and that therefore ABP considers that this part of the proposed road development would be contrary to the proposed planning of sustainable development of the area.

An application was made by a third party to the High Court seeking leave to issue judicial review proceedings against the ABP decision which granted approval of the eastern section of the 2006 GCOB under Article 6(3) of the Habitats Directive (92/43/EEC), as amended. The basis for the request for a review was that ABP had erred in its interpretation of Article 6 of the Habitats Directive (92/43/EEC), as amended, in arriving at the conclusion that the effect of the 2006 GCOB road scheme on the Lough Corrib cSAC designated site would not constitute an adverse effect on the integrity of the site.

The High Court undertook a judicial review of the ABP decision. The High Court decision of 9 October 2009 upheld ABPs decision to approve the eastern part of the scheme. On 6 November 2009, the third party was granted leave to appeal to the Supreme Court against the High Court decision of 9 October 2009. The Supreme Court sought the opinion of the Court of Justice of the European Union (CJEU) on an interpretation of the Habitats Directive.

The opinion of the CJEU was delivered on the 11 April 2013 (Case C-258/11). The opinion concluded on two significant points:

1. The 2006 GCOB would have an adverse effect on the integrity of the Lough Corrib cSAC due to the removal of 1.47ha of Limestone pavement (a habitat type for which the cSAC was selected)
2. Given that the 2006 GCOB would have an adverse effect on the integrity of the cSAC, the proposed scheme could not be authorised under Article 6(3) of the Habitats Directive. It could only be authorised under Article 6(4) of the Habitats Directive

The CJEU opinion (i.e. Case C-258/11) established that the loss of a relatively small area of Priority Annex I habitat, where it is a habitat for which the Lough Corrib cSAC is selected, would adversely affect the integrity of the Lough Corrib cSAC and that the provisions of Article 6(4) must apply in granting consent for the project i.e.

6(4) "If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted".

Following receipt of the CJEU opinion, the Supreme Court quashed the earlier ABP decision to grant approval of the eastern section of the 2006 GCOB under Article 6(3) of the Habitats Directive, as amended.

As the decision of the Supreme Court was that the original 2006 GCOB scheme could not be granted approval per Article 6(3) of the Habitats Directive, the next recourse to secure planning was to advance the scheme under Article 6(4) of the

Habitats Directive. Noting what ABP in its decision on the 2006 GCOB stated, namely that the need for an outer bypass of Galway City connecting the M6/N6 national primary road at Garraun to the R336 regional coast road, being an essential component of the strategic transport network of the Galway area, had been established and having reviewed the requirements of Article 6(4), it was decided to reassess the work to date to ensure that all possible alternatives were investigated in advance of proceeding under Article 6(4). Therefore, the process of developing a transportation solution for Galway City and its environs had to recommence from the start at Phase 1, feasibility and concept stage, to ensure that all possible alternatives were fully investigated.

Further consideration of the N6 Galway City Outer Bypass (2006) is detailed in **Chapter 4, Alternatives Considered**.

1.3.2 Development of a Transport Solution for Galway

The need for the proposed road development has been considered at both a regional level in terms of its strategic function, and at a local level in terms of providing an integrated transport solution for the city and environs. Therefore, the development of the transport solution has involved a wide selection of stakeholders, all of whom had an integral part in developing the vision but more critically all have an integral part in ultimately delivering the solution also.

Galway County Council, Galway City Council, Transport Infrastructure Ireland[10] (formerly known as National Roads Authority) and the National Transport Authority (NTA) collaborated in developing a transport vision for Galway where all elements of transport are working together to achieve an integrated sustainable solution. This section summarises the development of this transport vision, part of which includes the proposed road development.

The N6 Galway City Transport Project (GCTP) refers to the initial studies undertaken for the transport solution in Galway. The Galway Integrated Transport Management Programme (ITMP) began as the transport strategy developed by Galway City and County Council in partnership with the NTA in parallel to the N6 GCTP and is now referred to as the Galway Transport Strategy (GTS). The GTS has taken into account and seeks to achieve the objectives laid down in Smarter Travel. The N6 Galway City Ring Road is the road component of the transport solution identified in the N6 GCTP and orbital route identified in the GTS and the subject of this EIAR. This confirms that the proposed road development has been designed in accordance with the objectives of Smarter Travel and the above listed policies.

[10] The Minister for Transport, Tourism and Sport signed the order for the merger of the National Roads Authority (NRA) with the Railway Procurement Agency (RPA) to establish a single new entity called Transport Infrastructure Ireland (TII). The National Roads Authority is known as Transport Infrastructure Ireland (TII) since 1 August 2015. All references to guidance documents and standards within this report will retain the *NRA* reference until such time as these documents are updated.

1.3.2.1 N6 Galway City Transport Project

The initial studies for this transport solution were undertaken as part of the N6 Galway City Transport Project (GCTP). The N6 GCTP recognised that Galway has a transport problem and confirmed that there is a strong need to address the transport issues facing the city and surrounding areas at present, and to underpin future growth by establishing a long-term strategy for transport to, within and around the city. The studies undertaken for the N6 GCTP confirmed that a new River Corrib bridge crossing is possible and identified a preferred location for this crossing. The proposed road development which incorporates this river crossing is now referred to as the N6 Galway City Ring Road (GCRR) and is the subject of this EIAR.

Further details on the studies (such as constraints and options development) carried out as part of the N6 GCTP are provided in **Chapter 4, Alternatives Considered** of this EIAR.

1.3.2.2 Galway Transport Strategy

In parallel to the N6 GCTP, Galway City Council and Galway County Council, in partnership with the NTA developed an overall transport strategy for Galway City and its environs culminating as Galway Transport Strategy (GTS) which provides Galway City and its environs with a clear implementation framework for transportation over the next 20 years. The GTS aims to address the current and future transport requirements for the city and its environs, which encompasses the city and its connectivity to surrounding towns and villages, including Bearna, Oranmore, Moycullen and Claregalway.

Consultation with key stakeholders and the public was undertaken throughout to inform the development of the strategy. This strategy was subsequently endorsed by the elected members of both the City and County Council and forms part of the current Galway City Development Plan and Galway County Development Plan.

The GTS included an evaluation of transport options for all modes, and affirmed the strategic need for an orbital route around the city centre and a new crossing of the River Corrib, in order to implement the level of service required for each mode of transport, including walking, cycling, public transport and private vehicle.

In order to achieve a connected city and environs, the GTS seeks to deliver an integrated network of ‘links’ (routes) and ‘nodes’ (stops and interchange locations) along which people can travel seamlessly, changing corridors and modes as necessary to make their journey. Traffic within the city’s central area needs to be managed to make it a more comfortable environment for pedestrians and cyclists, and to ensure that public transport travelling through the city is reliable at all times of the day. This is essential to achieve a travel mode shift in favour of public transport. Key aims of the GTS are therefore to reduce vehicular movement through the city centre, to reduce vehicle speeds in the core city centre area, and to prioritise active modes (walking and cycling) and public transport in the city centre. The strategy therefore provides for routing of traffic which currently passes through the centre (to reach edge-of-centre locations) to more suitable orbital routes around the core city centre area.

The GTS recognised that some journeys across the city are not always convenient by non-car modes and considered it necessary to provide a resilient/reliable cross-city route via an orbital route for travel by road. The GTS requires the additional orbital traffic capacity so as to facilitate the re-allocation of existing road space for use by pedestrians, buses and cyclists, and noted that, unless additional capacity is provided for traffic, the overall objectives for the GTS will not be met.

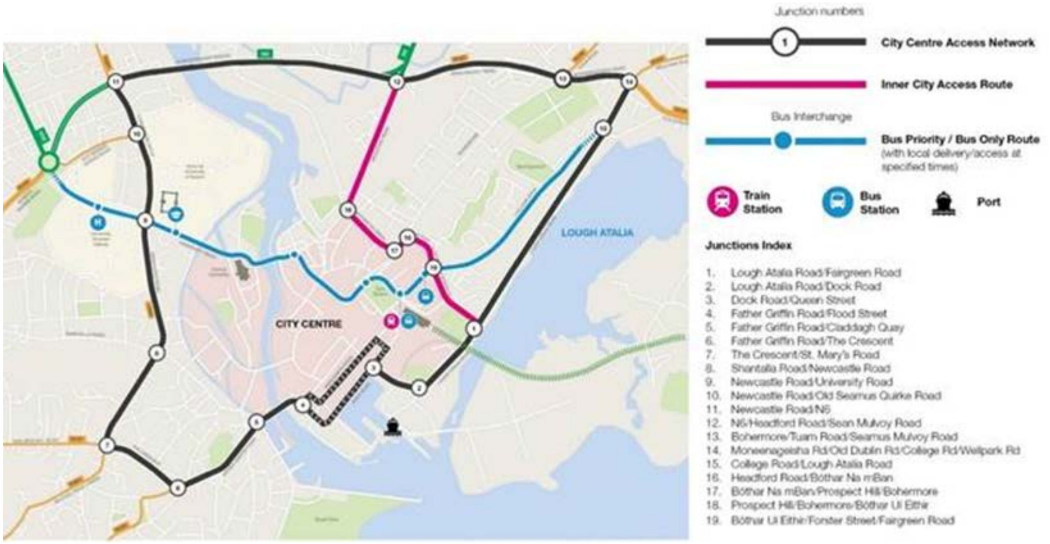
There are currently four crossings of the River Corrib and each bridge is currently at capacity. The GTS proposes to make one of these crossings available for public transport only, forcing traffic to divert out to the Quincentenary Bridge. Therefore, an additional crossing of the River Corrib is required to effectively implement the orbital route. This additional crossing of the River Corrib is being progressed as part of the N6 Galway City Ring Road (GCRR). ABP also considered in the 2006 GCOB Scheme that the need for an additional crossing of the River Corrib had been established.

A new road link to the north of the city is proposed as part of the GTS to deliver the necessary capacity and support the delivery of sustainable transport measures, particularly within the city centre. This new link road is being progressed as part of the N6 Galway City Ring Road (GCRR).

The routes through and around the city have been classified on different levels in order to separate journeys by type and assign the most suitable journey types to each road network or alternative mode. Heavy traffic flows that do not have a destination within the city centre will be encouraged to undertake their journeys via alternative routes, and through-traffic is to be removed from the city centre as much as is feasible. In doing so, and by adopting policies intended to change the hierarchy of transport users in the city at present, capacity can be released and safeguarded in the core city centre area, and subsequently this capacity can be used to prioritise sustainable transport modes.

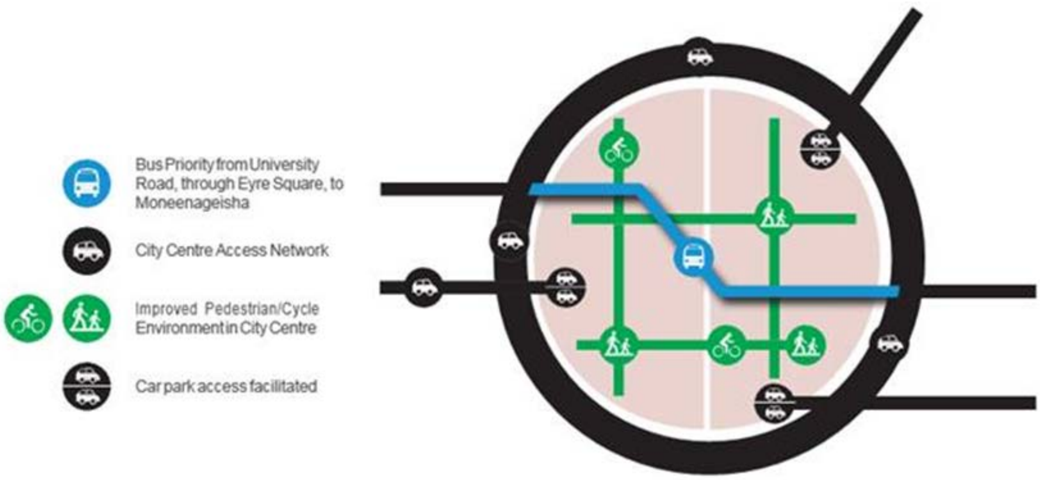
The GTS aims to remove non-essential motorised traffic from the core city centre area (i.e. traffic travelling through the city centre whose origin and destination lie outside the city centre). This will be achieved using a combination of routes around the city centre (termed the ‘City Centre Access Network’ shown in black in **Plate 1**), and will prioritise other modes within the core city centre area via the ‘Cross-City Link’ (shown in blue on **Plate 1**), a proposed corridor through the core city centre area with higher levels of priority allocated to walking, cycling and public transport over private car traffic.

Plate 1: City Centre Access Network



The core city centre area inside of the City Centre Access Network, will see road space reallocated to prioritise public transport and active modes. This will in turn facilitate public realm improvements along the Cross-City Link corridor, but requires changes in movements for private cars within the city centre to facilitate this. The city centre remains accessible, but priority is no longer given to the private car in this area or to the through movement in this area. This is best explained graphically in **Plate 2** below.

Plate 2: Cross-City Link Concept



Closing down and limiting access through the city within the area inside of the City Centre Access Network will facilitate a modal shift in the core area, whilst also shifting traffic out to the orbital route, which is the proposed road development. It is sequential: modal shift occurs within the core, and non-core traffic is shifted out to the orbital route. Therefore, the proposed road development, which is the subject of this EIAR, is a necessary component of the Galway Transport Strategy in order to deliver the transport solution for Galway. The achievement of maximum modal shift is contingent on the construction of the proposed road development (refer to **Chapter 6, Traffic Assessment and Route Cross-Section**).

The EIA process for the proposed road development is a stand-alone process and is not reliant on the other components of the GTS. Nevertheless, where relevant, the cumulative impacts of other proposals within the GTS will be assessed as part of the EIA process where applicable.

1.4 Consultation Process/Non-Statutory Consultation

Extensive consultation has taken place via public information sessions and discussions with key stakeholders, relevant statutory bodies, property owners, local organisations and utility/service providers throughout the constraints and route selection stages, design stage and during the EIA process.

Key stakeholders and statutory bodies included:

- An Bord Pleanála
- Galway County Council
    - Chief Executive
    - Director of Services for Planning, IR, Community, Enterprise & Economic Development
    - Director of Services for Water Services and Environmental
    - Director of Services for Roads, Transportation, Marine and General Services
    - Director of Services for Housing, Corporate & Emergency Services
- Galway City Council
    - Chief Executive
    - Director of Services for Planning & Transportation
    - Director of Services for Finance, Management Services Unit and Water Services
    - Director of Services for Economic Development, Community & Culture, Corporate Services, ICT and Human Resources
    - Director of Services for Housing & Social Inclusion, Environment & Recreation and Amenity
- The Minister for the Environment, Community and Local Government (now referred to as Minister for Housing, Planning, and Local Government with community and rural affairs forming a new department)
- The Minister for Communications, Energy and Natural Resources (now referred to as Minister for Communications, Climate Action and Environment)
- The Minister for Transport, Tourism and Sport
- The Minister for Arts, Heritage, Regional, Rural and Gaeltacht Affairs (now referred to as Minister for Culture, Heritage and Gaeltacht)
- Development Applications Unit of the Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs
- Department of Agriculture, Food and the Marine

- West Regional Authority
- Iarnród Éireann
- Córas Iompair Éireann
- Bus Éireann
- City Direct
- Galway Harbour
- Transport Infrastructure Ireland (TII)
- An Chomhairle Ealaíon (The Arts Council)
- Fáilte Ireland
- An Taisce
- The Heritage Council
- Waterways Ireland
- Environmental Protection Agency (EPA)
- Health and Safety Authority
- Commission for Energy Regulation
- Health Service Executive
- Office of Public Works
- Bat Conservation Ireland
- Bird Watch Ireland
- Irish Raptor Study Group
- Irish Georgian Society
- Geological Survey of Ireland
- American Chamber of Commerce
- Galway Chamber of Commerce
- Inland Fisheries Ireland
- Inland Waterways Association of Ireland
- Irish Wildlife Trust
- Met Éireann
- Irish Farmers Association
- Irish Peatland Conservation Trust
- National Museum of Ireland
- National University of Ireland, Galway
- Galway City Development Board
- Galway County Development Board

1.4.1 Public Consultation

Four public information sessions were held as follows and are discussed further below:

- Public Consultation No. 1 as part of the Constraints Study in July 2014 over two days
- Public Consultation No. 2 as part of the Options Development in January/February 2015 over four days
- Public Display No. 3 of the Emerging Preferred Route Corridor for the N6 Galway City Ring Road in May/June 2015 over two days. The Galway Transport Strategy also formed part of this consultation
- Public Display No. 4 of the Design of the N6 Galway City Ring Road in November 2016

Feedback received from the public consultations informed the constraints study and development of route options and the design of the emerging preferred route once selected. The local knowledge received at the public consultation and through submissions received identified new constraints and informed the development of route options and selection of the emerging preferred route corridor (EPRC). It also reinforced the traffic problems experienced in Galway City and its environs and need for an integrated transport solution which was multi-modal. This led to a parallel study of public transport and smart mobility measures which culminated in the Galway Transport Strategy (GTS). The historical importance of Menlough Village and the extents of communities across the study area were better understood post public consultation. The consultations with the public also reinforced the significant constraints present restricting the development of a new road and whilst some of the significant impacts were unfortunately unavoidable some positive changes were implemented into the design. Some of these include: the junction strategy in the Bearna Area and the retention of the mass path in Parkmore; landscape and visual improvement including the lowering of the proposed road development from an overbridge to at-grade junction at Cappagh Road and changing from an overbridge at Hynes' Boreen in Castlegar to being in a cutting to at-grade; moving the N59 Letteragh Junction further west and revision of the Coolagh Junction. 'Green reinforced embankments' instead of concrete retaining walls have also been incorporated into the design where the proposed road development is in close proximity to dwellings. These enhancements and others made to the design following feedback from public consultations is detailed further in **Chapter 4, Alternatives Considered**.

1.4.1.1 Public Consultation No. 1 – Constraints

As part of the Constraints Study, public consultation sessions were held on Monday 14 July 2014 in the Westwood Hotel, Dangan from 10:00am to 9:00pm and on Tuesday 15 July 2014 in the Pillo Hotel, Headford Road from 10:00am to 9:00pm.

The initial results of the constraints study were displayed to the public at the consultation sessions. The aim of this was to receive feedback from the public and gain invaluable information from their local knowledge of constraints that may have been overlooked.

Representatives from Arup and Galway County Council were in attendance to assist the public in explaining the material on display. Over 100 people signed the attendance register.

The main feedback from this public consultation was as follows:

1. The scheme study area should extend further west and north
2. Concerns were raised in relation to the restrictions on lands located along the road of the N6 Galway City Outer Bypass (2006)
3. An additional crossing of the River Corrib was required and this new bridge should not adversely affect the navigation of the River Corrib
4. Current traffic and congestion issues, including inadequacies in the current public transport network were highlighted. Bus frequencies, routes and infrastructure need to be improved
5. Provision of a connection to the R336 west of Bearna
6. Proposals to tunnel under the Limestone pavement
7. Provision of school buses would provide a safe mode of transport for children and ease congestion at peak morning times
8. Additional constraints were identified

Full details of this consultation and submissions received from the public are contained in **Appendix A.1.1**.

1.4.1.2 Public Consultation No. 2 – Options

Public consultation sessions were held on Wednesday 28 and Thursday 29 of January 2015 in the Westwood Hotel, Dangan, from 2.00pm to 8.00pm, and on Tuesday 3 and Wednesday 4 of February 2015 in the Menlo Park Hotel from 2.00pm to 8.00pm. Over 1,450 people signed the attendance register over the four days of public consultation sessions.

These sessions formed part of the option selection process. Boards documenting the options examined to date and their feasibility were displayed, along with proposed solution options incorporating public transport, smarter travel and road-based components. Maps showing proposed road-based solutions with the constraints gathered during the Constraints Stage were also displayed. Representatives of Arup and Galway County Council were available throughout the sessions to answer questions and explain the material on display as needed. The aim of the public consultation sessions was to receive feedback and suggestions from the public regarding the proposed solutions. Submissions from the public of suggestions of possible modifications to the options presented, or additional information on further constraints, which may not have been taken into account at Constraints Stage, were welcomed both during the consultation sessions and afterwards, until the 6 March 2015.

Individual meetings with landowners, stakeholders, business owners and residents within the scheme study area were held in the weeks following the formal consultation. These were held at the request of the private individuals and drawings were prepared for each one to show the proximity of their property to the proposed road component options. Feedback from these meetings and submissions received were noted and any further constraints were sent to the full design team including the environmental specialists for inclusion in their assessment.

The main feedback from this public consultation are as follows:

- Greater importance given to the protection of environmental habitats over humans
- Viability of going back to the 2006 GCOB scheme
- Impacts of demolition to homes and businesses
- Impact on the environment, noise and air pollution
- Impact to communities and cultural heritage of many townlands e.g. Menlough, Castlegar, Coolagh, Rahoon, Dangan/Bushypark, Knocknacarra and Bearna
- Impact on recreational amenities such as NUIG Sporting Campus
- Health and safety of primary school children in close proximity to proposed routes
- Impact to commercial businesses and local economy of Galway
- Implementation of improved public transport and smarter mobility

Full details of this consultation and submissions received from the public are contained in **Appendix A.1.2**.

1.4.1.3 Public Display of Emerging Preferred Route Corridor

Public display sessions were held on 25 and 26 May 2015 on the Emerging Preferred Route Corridor (EPRC) at two locations in Galway, one west of the River Corrib and one east of the River Corrib. Details of the EPRC and the route selection process were on display over the two-day period and were available at the project office until the end of August 2015.

Galway City Council in conjunction with the National Transport Authority (NTA) also consulted with the public over this two-day period on the details of the Integrated Transport Management Programme (ITMP) (now referred to as the GTS). The display boards for the ITMP were moved to City Hall for unattended viewing following the public display sessions.

The joint presentation and consultation on the overall solution was very worthwhile as it afforded the public an opportunity to see how the component parts of the solution fit together to deliver an overall transport solution.

The general feedback on the road component of the transport solution included commentary on the following issues:

1. Implementation of improved public transport and smarter mobility should be prioritised over a road scheme
2. Greater importance given to the protection of environmental habitats over humans
3. Viability of going back to the N6 Galway City Outer Bypass (2006) route in the Bearna area
4. Impacts of demolition to homes and businesses
5. Impact to communities and cultural heritage of many townlands e.g. Castlegar, Coolagh, Dangan/Bushypark and Bearna

Further design iterations were necessary to minimise and reduce the extent of the impacts on the residential communities; this process formed part of the *Phase 3 Design* work.

Full details of this consultation and submissions received from the public are contained in **Appendix A.1.3**.

1.4.1.4 Public Display of Design of the proposed road development

A public display to provide an update on the design development of the N6 Galway City Ring Road was held in both Galway County and City Council Offices during normal working hours Monday to Friday from the 14 November to 2 December 2016.

General feedback on the proposed design included queries on the project's planning process and specific requests from landowners for design changes in the vicinity of their property to better mitigate the impact of the proposed road development. This is further detailed in **Chapter 4, Alternatives Considered**.

1.4.1.5 Continuous public consultation

A project website was created and used to keep the public informed at all stages as the N6 GCRR project progressed.

Over 950 individual property owner meetings, including many home visits, took place between the design team and property owners and such consultation informed the design of the proposed road development and the environmental impact assessment.

All property owners identified as owning lands to be acquired to facilitate the construction of the proposed road development received written correspondence in October 2016 with a copy of the design with respect to their property. As part of the final consultation process, written communication was issued to all property owners again in May 2018 with a copy of the final design with respect to their property and an explanation of the next steps.

1.5 Difficulties Encountered during the Study

No significant difficulties were encountered during the preparation of this EIAR. Any technical limitations associated with assessment of an environmental aspect are detailed in the relevant EIAR chapter.

1.6 References

Environmental Protection Agency. (2017) *Draft Guidelines of the Information to be contained in Environmental Impact Assessment Reports, 2017*.

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European Commission (2017). *Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU*.

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European Commission. (2006) *Clarification of the application of Article 2(3) of the EIA Directive.*

European Commission. (1999) *Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions.*

Transport Infrastructure Ireland. (formerly National Roads Authority) (2008) *Environmental Impact Assessment of National Road Schemes – A Practical Guide.*

2 Planning and Policy Context

2.1 Introduction

This chapter addresses the strategic planning policy context and strategic transport policy for the N6 Galway City Ring Road, hereafter referred to as the proposed road development. The purpose of this chapter is to set out the relevant strategic and statutory land use and planning policy context, and strategic transport policy context for the proposed road development.

Please refer to **Chapter 5, Description of Proposed Road Development** for description and overview of the route of the proposed road development.

This chapter sets out the current strategic transport policy and objectives, and the planning policy and objectives pertinent to the proposed road development.

It is set out as follows:

- European Context (**Section 2.2**)
- National Objectives (**Section 2.3**)
- Regional Policies, Guidance and Objectives (**Section 2.4**)
- Local Policies, Guidance and Objectives (**Section 2.5**)

An overall conclusion on how the European, national, regional and local policies support the proposed road development is included in **Section 2.6** and references in **Section 2.7**.

The proposed road development is congruent with current transport policy and planning policy as set out in the various policy documents over the past number of years. Specific details for each of the policies and how the proposed road development complies with these, and more local and regional policies, are outlined below.

2.2 European Context

The EU Sustainable Development Strategy (EU SDS, 2001, reviewed 2009), is a framework for a long-term vision of sustainability in which economic growth, social cohesion and environmental protection go hand in hand and are mutually supporting. In developing EU Transport Policy, the EU states in its 2009 review *Mainstreaming sustainable development into EU policies: 2009 Review of the European Union Strategy for Sustainable Development (pp. 6)* that it is essential to take account of all aspects of sustainability (such as emissions, noise, land occupancy and biodiversity) and to base any action on a long-term vision for the sustainable mobility of people and goods that covers the entire transport system, and on complementary efforts at EU, national and regional levels.

The EU SDS dedicates one of its seven key challenges to sustainable transport, with the overall objective to 'ensure that our transport systems meet society's economic, social and environmental needs whilst minimising their undesirable impacts on the economy, society and the environment'. The EU SDS operational objectives and targets include:

- Decoupling economic growth and the demand for transport with the aim of reducing environmental impacts
- Achieving sustainable levels of transport energy use and reducing transport greenhouse gas emissions
- Reducing pollutant emissions from transport to levels that minimise effects on human health and/or the environment
- Achieving a balanced shift towards environment friendly transport modes to bring about a sustainable transport and mobility system
- Reducing transport noise both at source and through mitigation measures to ensure overall exposure levels minimise impacts on health
- Modernising the EU framework for public passenger transport services to encourage better efficiency and performance

The Europe 2020 strategy unites two flagship initiatives under the sustainable growth priority to tackle the issue of sustainable transport:

- 'Resource efficient Europe' supports the shift towards a resource-efficient, low-carbon economy. This flagship initiative provides a framework for actions in many policy areas including transport. One of the key components is a roadmap presenting a vision for a transport system by 2050 that promotes clean technologies
- 'An industrial policy for the globalisation era' highlights ten key actions for European industrial competitiveness, including a more efficient European transport infrastructure and services.

It is within this broader EU policy context that the proposed road development is set. The proposed road development meets these objectives by providing the necessary infrastructure to support the economic growth of Galway and the Western Region and will also enable other public projects be realised and facilitates the effective implementation of the Galway Transport Strategy which includes improved public transport, walking and cycling measures for Galway City and its environs. This is further detailed in **Chapter 3, Need for the Proposed Road Development**.

2.2.1 Ten-T Connecting Europe

As of January 2014, the European Union (EU) has a new transport infrastructure policy, entitled *Infrastructure - TEN-T - Connecting Europe* that connects the continent between East and West, North and South. This policy aims to close the gaps between Member States' transport networks and to remove bottlenecks that still hamper the smooth functioning of the internal market. It is recognised that integrated transport networks are essential to a single market.

The aim of the EU's Transport Policy is to promote a mobility that is efficient, safe, secure and environmentally friendly. Congestion is not just a nuisance for road users; it also results in an enormous waste of fuel and productivity. Many manufacturing processes depend on just-in-time deliveries and free flow transport for efficient production. Congestion costs the EU economy more than 1% of GDP – in other words, more than the EU budget. To reduce this, the EU needs more efficient transport and logistics, better infrastructure and the ability to optimise capacity use.

The EU Commission also recognises that Europe needs transport which is cleaner and less dependent on oil. Moving towards low-carbon and more energy efficient transport, as well as developing more efficient urban and intermodal transport solutions as alternatives are essential to developing a more environmentally friendly transport policy.

The European Transport Infrastructure (TEN-T) includes the core transport routes in all EU Member States for all transport modes: air, rail, road, maritime and inland waterways and consists of two planning layers, namely the core transport network and the comprehensive transport network. The core network represents the major transport corridors connecting Europe and it stretches from Ireland through the United Kingdom and onto mainland Europe. This core network is supported by the comprehensive network. The proposed road development is classified as part of the TEN-T comprehensive road network[1] shown in **Plate 2.1** below as it is a strategic link in the road network in the West Region functioning in accordance with the European Union's (EU) TEN-T transport policy.

[1] http://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/map/maps.html

Plate 2.1: TEN-T Network Ireland (Source Transport Infrastructure Ireland)

The objectives of the proposed road development align with the European Union's land transport policies given that the following targets are among the objectives of the proposed road development, whose targets meet those set out in the EU SDS operational objectives and targets, as set out above (ref: **Chapter 3**, **Section 3.3** of this report for the Project Objectives):

- Segregation of the interface of by-passable traffic from urban traffic
- Increase journey time certainty
- Reduce journey times
- Implement sustainable transport policies for shorter commutes
- Improve accessibility to Galway City and the connectivity of key strategic services within Galway, such as NUIG and Galway University Hospital
- Improve accessibility of the Galway urban area to its main markets
- Ensure connectivity and accessibility of this region to the single European market, including the port of Rossaveel, Connemara Airport and the Gaeltacht areas which lie west of the city along the R336
- Improve linkages between the west and east sides of the city and the county
- Improve accessibility of the Gaeltacht areas to the remainder of the county and country
- Recognition of the role of Galway City as a gateway to the west and Connemara, and the consequent socio-economic benefits of enhanced connectivity of

Galway City to national markets, enhanced tourism accessibility, and the national transport system
- Improvement to the TEN-T network to ensure connectivity of the west of Ireland to the single European market

The proposed road development forms part of the TEN-T comprehensive road network in Ireland and is of strategic importance in a European context as it has a key role in delivering congestion relief, reducing greenhouse gas emissions and strengthening economic cohesion. This is further detailed in **Chapter 3, Need for the Proposed Road Development**.

2.3 National Objectives

2.3.1 Building on Recovery: Infrastructure and Capital Investment Plan 2016-2021

This Capital Plan presents the Government's new framework for infrastructure in Ireland over the period 2016-2021. A recovering economy, jobs growth, and strengthening public finances means the Government revised its capital expenditure commitments for the remainder of the decade recognising that '*High quality infrastructure is an important element of a modern society and economy. It strengthens economic growth through enhancing efficiency, productivity and competitiveness*'.

The transport capital allocation in this Capital Plan is largely framed by the recommendations and priorities set out in the 2015 Department of Transport, Tourism and Sport (DTTaS) *Strategic Investment Framework for Land Transport,* which centre on:

- maintaining and renewing the strategically important elements of the existing land transport system
- addressing urban congestion
- maximise the contribution of land transport networks to national development, including providing access to poorly served regions

The Capital Plan incorporates the following key objectives relevant to this proposed road development:

- €6 billion for investment in the national, regional and local road network over the 7-year period, with €4.4 billion to ensure the existing extensive network throughout the country is maintained and strengthened, with €1.6 billion for new projects
- It supports the proposed road development specifically by reference to supporting the commencement of the '*Galway By-Pass'* subject to planning permission

The proposed road development is consistent with these recommendations, priorities and objectives as set out in the DTTaS 2015 investment framework, and the Capital Plan, as it seeks to deliver the N6 Galway City Ring Road, address urban congestion in Galway City, and enhance national development through improved connectivity to west Galway.

This connectivity is essential to ensure the viability of the western parts of the county which have a very high quality tourist offering which is dependent on connectivity to achieve its potential.

County Galway has a thriving tourism industry which contributes to the national tourism industry. There were over 1.3 million overseas visitors to Galway in 2015 alone, generating an estimated €475 million in revenue (Fáilte Ireland Regional Tourism Performance by County 2015, Oct. 2016). At the time of publication of this report, data for 2016 was unavailable but initial findings indicate an increase in tourism across Ireland in 2016. Approximately, two thirds of the tourists visit the area in the period from May to September, with one of the main attractions being Connemara with its scenic landscapes and unpolluted environment. Tourism traffic, together with local recreation traffic accessing the beaches at the west of the city, add to the traffic volumes on this linear transport corridor in this summer period. Galway is also located on the Wild Atlantic Way which is a new initiative by Fáilte Ireland to encourage tourism into the west and is likely to generate additional traffic into the area.

Tourism is a vital industry to ensure the viability and survival of the South Connemara region, which is linked to overall improved social provision, quality of life and environmental sustainability.

A review of the Capital Plan was published in August 2017 as there was a significant improvement in economic performance of the country which enabled the allocation of additional capital investment for increased public capital investment over the period of the Capital Plan. The increased expenditure is targeted to achieve specific outcomes which achieve value for money.

Following the allocation of this increased capital investment, the Government published a new 10 year national investment plan for the period 2018-2027, namely the National Development Plan 2018-2027, which closely aligns with the key objectives of the National Planning Framework to ensure the money is spent in accordance with an overall plan.

2.3.2 Smarter Travel, A Sustainable Transport Future, 2009 and Irelands National Cycle Policy Framework, 2009 to 2020

"*Smarter Travel – A Sustainable Transport Future*" is a policy framework approved by Government in 2009 which sets out how the vision of a sustainable travel and transport system can be achieved. The policy acknowledges that "*transport is vital for our economy. As an island nation we need good transport connections with our trading partners; we also need to ensure efficient movement on the island. Safe and comfortable travel is also a key element of a good quality of life. The issue is not to restrict travel and transport but to facilitate smarter ways of meeting these needs*". Chapter 3 of the policy document outlines five key goals which form the basis of the Policy as follows:

- *Improve quality of life and accessibility to transport for all and, in particular, for people with reduced mobility and those who may experience isolation due to tack of transport*
- *Improve economic competitiveness through maximising the efficient of the transport system and alleviating congestion and infrastructural bottlenecks*
- *Minimise the negative impacts of transport on the local and global environment though reducing localised air pollutants and greenhouse gas emissions*
- *Reduce overall travel demand and commuting distances travelled by the private car*
- *Improve security of energy supply by reducing dependency on imported fossil fuels*

Key actions set out in the Smarter Travel policy to achieve this vision include:

- Actions to reduce distance travelled by private car and encourage smarter travel, including focusing population growth in areas of employment and to encourage people to live in close proximity to places of employment and the use of pricing mechanisms or fiscal measures to encourage behavioural change
- Actions aimed at ensuring that alternatives to the car are more widely available, mainly through a radically improved public transport service and through investment in cycling and walking

In keeping with Smarter Travel policy, a national cycle policy was announced in 2009. *Ireland's National Cycle Policy Framework, 2009 to 2020* sets out to create a strong cycling culture in Ireland with a target level of 10% of all trips to be made by bike by 2020. The key to achieving the Government target of 10% commuting by bike by 2020 is threefold; firstly, planning at all levels needs to consider cyclist needs; secondly, transport infrastructure must provide cycle friendly safe direct routes; and finally, education and communication is necessary to foster a cycling culture from a young age.

Over the years, Galway City and Galway County Council have developed a number of plans and strategies to help achieve national Smarter Travel policy objectives. These include:

- Galway Metropolitan Smarter Travel Area Action Plan 2010-2015
- Galway City and Environs Walking and Cycling Strategy (2010)
- Galway Transport Strategy (2016)

In 2010, Galway City and Galway County Council developed the *Galway Metropolitan Smarter Travel Area Action Plan 2010-2015* which was in line with the first key goal of the Smarter Travel national policy and set out to develop Galway and its hinterland as a sustainable travel area. This Plan assumed that the 2006 N6 Galway City Outer Bypass (GCOB, 2006) was delivered.

In 2010, Galway City and Galway County Council also developed the *Galway City and Environs Walking and Cycling Strategy (2010)* which sought to deliver on national cycle policy at the Galway City level, again in line with the first key goal of the policy to provided facilities for pedestrians, cyclists and non-motorised users (NMU). Proposals included a greenway from the city centre to Bearna and from the city centre to Oughterard.

In 2016, Galway City and Galway County Council in partnership with the National Transport Authority developed the *Galway Transport Strategy* (GTS). This strategy builds on the previous transport studies carried out for the Galway Region and sets out an overview of the proposed actions and measures for implementation, covering infrastructural, operational and policy elements. These consolidated proposals will provide Galway City and its environs with a clear implementation framework for the next 20 years and will underpin the objectives of the current and future Galway City and Galway County Development Plans. Smarter Travel forms the core principle of the Galway Transport Strategy. The GTS is further detailed in **Section 2.5.1** below with a background to the GTS included in **Chapter 1, Introduction**.

The GTS is currently being implemented by Galway City Council, both in terms of the policy objectives established and the delivery of transport projects identified within the strategy. The N6 GCRR forms part of, and is identified as a project within the ‘Galway Transport Strategy’ (GTS).

The GTS aligns with the Key Goals set out above in its efforts to align land use and transportation policy, and in seeking to deliver viable and attractive alternatives to the private car in Galway.

The proposed road development forms part of the actions set out in the Galway Transport Strategy (GTS) and it aligns with smarter travel policies both at a national level and local level. In developing the GTS, cognisance was taken of the Smarter Travel policy to ensure maximum uptake of public transport. Therefore, the GTS aligns with the Smarter Travel policies in so far as full implementation of the GTS (of which the N6 GCRR is a significant component) results in an improvement of 16% in modal shift to public transport.

It is necessary to resolve existing traffic congestion issues in Galway in order to achieve smarter travel policies. The proposed road development will assist with the removal of traffic congestion from within Galway City and its environs by transferring existing and future traffic from the existing road network to the new road infrastructure. Therefore, journey times will reduce and journey time certainty will increase for both public transport and private vehicle users. The reduction in traffic congestion will also help to realise other proposed actions in the Galway Transport Strategy because the existing road space can be reallocated for cyclists, pedestrians and to reconfigure the public transport network. This will result in reducing the number of short commuter journeys by car by facilitating journeys by bicycle which are faster, cheaper, and more sustainable and generate health benefits.

Improvements to the Galway bus network have been identified as necessary to better cater for existing and future travel patterns in Galway City. The reallocation of road space for public transport will assist with the delivery of an improved bus network.

Achieving the targets as set out in Smarter Travel policies will deliver a more attractive, vibrant and economic Galway City and environs with associated health and environmental benefits, all of which are necessary for sustainable travel into the future. The proposed road development aligns with these policies both at a national and local level.

Smarter Travel – A Sustainable Transport Future notes that efficient movement of goods is vital to our competitiveness and economic welfare with the majority of goods currently moved by road. It also acknowledges that investment in roads will remove bottlenecks, ease congestion and pressures in town and villages. Therefore, the actions set out in the policy seek to balance the multiple functions of the road network whilst still achieving the overall key goals.

The policy document sets out 49 Actions identified to achieve these key goals. The provision of the proposed road development supports a number of the 49 actions contained within the Smarter Travel Policy, and is neutral with the remaining as detailed in **Table 2.1** below.

Table 2.1: Smarter Travel Action Compliance Assessment

Action Number	Compliance	Comments
1	Supportive	The reallocation of road space to facilitate the provision of new and improved pedestrian and cycling facilities promotes walking and cycling to access community facilities and public transport throughout Galway City. The proposed road development provides such facilities in all areas of overlap with proposed GTS measures including but not limited to Cappagh Road, Ballymoneen Road, N59 Link Road, Letteragh Road, Rahoon Road, N59, N84, N83[2], Castlegar Road, Parkmore Link Road, Ballybrit Crescent, City East Business Park Junction. Refer **Section 5.5.4.2 Pedestrian and Cyclist Provision**.
2	Supportive	Provision of new pedestrian and cycle facilities in all areas of overlap with proposed GTS measures including but not limited to Cappagh Road, Ballymoneen Road, N59 Link Road, Letteragh Road, Rahoon Road, N59, N84, N83, Castlegar Road, Parkmore Link Road, Ballybrit Crescent, City East Business Park Junction supports the sub-actions under Action 2 relating to integration.
3	Supportive	The proposed road development comprises two local authority areas, namely Galway City Council and Galway County Council, with Galway County Council progressing the proposed road development through the statutory process on behalf of itself and Galway City Council. In parallel, Galway City Council and Galway County Council, in partnership with the NTA developed an overall transport strategy for Galway City and its environs culminating in the Galway Transport Strategy (GTS), of which the proposed road development is a key component. The GTS provides Galway City and its environs with a clear implementation framework for transportation over the next 20 years. This coordination will ensure coordination and integration of development planning between local authorities across the Gateway of Galway.

[2] Formally known as the N17 Tuam Road.

Action Number	Compliance	Comments
4	Supportive	The provision of the pedestrian and cycle facilities noted in Action 1 above is supportive of Action 4 in promoting more sustainable travel patterns, such as cycling and walking. The provision of a dedicated bus lane on the N83 is supportive of Action 4 in promoting more sustainable travel patterns. The Parkmore Link Road links the Ballybrit and Parkmore Industrial Estates and facilitates the interchange of bus routes servicing these Industrial Estates thus increasing the level of provision of public transport into the whole of the north eastern quarter of the city. It also provides a shorter direct route with full provision of appropriate infrastructure along the desire line for both pedestrians and cyclists to the Industrial Estates of Parkmore and Ballybrit.
5	Neutral	The provision of the proposed road development will not impact on e-working targets for the public sector. All existing broadband and telephony services impacted by the proposed road development will be reconnected to ensure no loss of service.
6	Neutral	The provision of the proposed road development will not impact on establishment of e-working centres. All existing broadband and telephony services impacted by the proposed road development will be reconnected to ensure no loss of service.
7	Supportive	The proposed road development does provide segregated safe routes for pedestrians from the N59 at Bushypark to Letteragh Road. It then connects to dedicated cycleways and footways on the N59 Link Road South to the Gort Na Bró Link Road. These cycleways and footways connect into the existing networks in the area which feed four major secondary schools on Threadneedle Road, Ballymoneen Road and Taylors Hill. This link road also provides safe routes to connect the residential areas of Letteragh Road to Rahoon Road thus avoiding the existing circuitous route via Seamus Quirke Road. The reduction in traffic volumes within Galway City will also assist improving the safety within the city centre for vulnerable road users and provide the platform for future enhancements to pedestrian and cycle amenities as per the GTS.
8	Supportive	The proposed road development will provide dedicated safe routes for vulnerable road users on the west of the city that connects housing developments to the schools. Provision is also made to connect the major business parks on the east of the city by means of the Parkmore Link Road. The Parkmore Link Road facilitates the interchange of bus routes servicing these Industrial Estates supporting a modal shift to non-motorised forms of transport for commuting to workplaces within the whole of the north eastern quarter of the city. It also provides a shorter direct route with full provision of appropriate infrastructure along the desire line for both pedestrians and cyclists to the Industrial Estates of Parkmore and Ballybrit. A southbound bus lane, dedicated cycle lanes and pedestrian facilities are provided on Ballybrit Crescent Road which provide safe routes from Parkmore East Industrial Estate through the Lynch Junction. All other signalised junctions within the proposed road development provide facilities for vulnerable road users to safely negotiate the junctions.

Action Number	Compliance	Comments
9	Supportive	The provision of the proposed road development does not actively promote personalised travel plans. However, it offers the opportunity to individuals to reconsider their existing travel patterns and move towards a more sustainable travel plan especially in the Parkmore/Ballybrit area and in the western suburbs of Knocknacarra/Rahoon/Westside. In addition, the wider GTS supports such initiatives throughout the city centre.
10	Neutral/Supportive	The provision of the proposed road development will not impact on the promotion of freight policy. There will be a reduction in traffic volumes on the dedicated access route to Galway Port, thus facilitating the efficient movement of goods to/from the port. The reduction in congestion in Galway City and environs will improve the efficiency of road based freight traffic.
11	Neutral	The proposed road development will not impact on the implementation of fiscal measures aimed at reducing car use.
12	Supportive	The provision of a dedicated bus lane on the N83 promotes more sustainable travel patterns. The Parkmore Link Road facilitates the interchange of bus routes servicing these Industrial Estates. A southbound bus lane is provided on Ballybrit Crescent Road to facilitate the bus route from Parkmore East Industrial Estate through the Lynch Junction. These combined measures increase the level of provision of public transport into the whole of the north eastern quarter of the city, into which combined workforce of 10,000 travel daily. The provision of the proposed road development will reduce the current congestion experienced in Galway City Centre and facilitates the provision of a public transport corridor through the city centre with public transport only allowed on the Salmon Weir Bridge, Eglington Street and College Road.
13	Supportive	The provision of a dedicated bus lane on the N83 forms part of the provision of a reliable bus service into the large urban area of Galway City. The Parkmore Link Road facilitates public transport between the Ballybrit and Parkmore Industrial Estates and facilitates the interchange of bus routes servicing these Industrial Estates, again ensuring a reliable public transport to the north eastern quarter of the city. The provision of the proposed road development will reduce the current congestion experienced in Galway City Centre and facilitates the provision of a public transport corridor through the city centre with public transport only allowed on the Salmon Weir Bridge, Eglington Street and College Road.
14	Supportive	The provision of the proposed road development supports the action to provide a dedicated public transport route along the N83 corridor, thus facilitating access from the rural area of Claregalway to the city centre. The provision of the Parkmore Link Road connects the Ballybrit and Parkmore Industrial Estates and facilitates the interchange of bus routes servicing these Industrial Estates, In the wider GTS measures, it is envisaged to use this route to link to a future Park and Ride. A southbound bus lane is provided on Ballybrit Crescent Road to facilitate the bus route from Parkmore East Industrial Estate through the Lynch Junction. In the wider GTS measures, it is

Action Number	Compliance	Comments
		envisaged that this route could link to a future Park and Ride site in the Coolagh Roundabout area.
15	Supportive	The provision of the proposed road development supports Action 15, through the provision of dedicated high quality safe pedestrian and cycling facilities linking the residential areas and employment areas. It will be possible to cycle from Cappagh Road to Parkmore West Industrial Estate on a dedicated cycle path, i.e. from the western city limits to the north-eastern city limits. The reduction in traffic volumes in Galway City Centre due to the transference of traffic to the new alignment will afford the opportunity to improve the cycling infrastructure.
16	Supportive	The provision of the proposed road development supports Action 16, through the provision of dedicated high quality safe pedestrian facilities on the N59 Link Road North and South, the Parkmore Link Road, Ballybrit Crescent Road and all the signalised junctions. The reduction in traffic volumes in Galway City Centre will afford the opportunity to further improve the pedestrian infrastructure.
17	Neutral	The proposed road development does not utilise State owned lands for the provision of walking and cycling facilities. However, the walking and cycling facilities provided all link into the greater strategy for walking and cycling in Galway and environs which ultimately gives access to the wider greenway network.
18	Neutral	The provision of the proposed road development will not impact on the establishment of car sharing website and initiatives.
19	Neutral	The provision of the proposed road development will not impact on the establishment of car club schemes.
20	Neutral	The provision of the proposed road development will result in reduced traffic volumes in Galway City Centre, thereby facilitating the advancement of other schemes to give traffic priority to other forms of motorised transport.
21	Neutral	The provision of the proposed road development will not impact on the implementation of integrated ticketing systems on the public transport network.
22	Supportive	The provision of the Parkmore Link Road and the bus lane on Ballybrit Crescent Road facilitate the establishment of future park and ride sites along major public transport modes. These provisions form part of the overall plan for park and ride facilities in the GTS.
23	Supportive	Signalised junctions are provided within the proposed road development to enhance operational safety and performance and to facilitate the efficient movement of all road users. Dedicated crossing points for pedestrians and cyclists are provided at each junction location. The traffic reductions in Galway City Centre will afford the opportunity to improve the pedestrian priority at the key junctions.
24	Neutral / Supportive	The provision of the proposed road development will not impact on the implementation of an on-line integrated journey planner. The work on the development of the overall transport strategy

Action Number	Compliance	Comments
		was managed by the National Transport Authority in parallel, thus ensuring integration of all transport modes.
25	Supportive	The proposed road development provides investment for new dedicated, safe walking and cycling routes linking residential areas to employment areas and the city centre. The reduction in traffic volumes in the city centre will facilitated further improvement to the pedestrian and cycling infrastructure within the city centre. The proposed road development will provide economic benefits through alleviation of the congestion and journey time reliability.
26	Neutral	The implementation of the proposed road development will not impact on the restructuring of the air navigation system in Europe and Ireland.
27	Neutral	The implementation of the proposed road development will not impact on the public service obligation for regional air transport services.
28	Neutral	The implementation of the proposed road development will not impact on the maritime transport sector emissions.
29	Neutral	There will be a reduction in traffic volumes on the dedicated access route to Galway Port, thus facilitating the efficient movement of goods to/from the port. The reduction in congestion in Galway City and environs will improve the efficiency of road based freight traffic.
30	Supportive	The provision of the proposed road development will provide a safer road for motorised traffic, removes traffic including heavy goods vehicles from congested urban areas and facilitates the reallocation of the existing road space for public transport and non-motorised transport, thus supporting a mobility that is efficient and is a safer environment for active modes.
31	Neutral	The implementation of the proposed road development will not impact meeting the 10% target for Bio-fuels by 2020.
32	Neutral	The implementation of the proposed road development will not impact in meeting the 10% target for electric vehicle technology by 2020.
33	Neutral	The implementation of the proposed road development will not impact on the implementation of fuel efficient vehicle fleets in the public sector.
34	Neutral	The implementation of the proposed road development will not impact on the implementation of VRT and Motor Tax systems.
35	Neutral	The implementation of the proposed road development will not impact the Sustainable Energy Ireland (SEI) initiatives to introduce energy efficient technologies to the transport sector.
36	Neutral	The implementation of the proposed road development will not impact on efficient driving module of the national driver test and implementation of on-board technologies to encourage eco-driving behaviour.
37	Neutral/Supportive	The implementation of the proposed road development will not impact the introduction of a Sustainable Travel and Transport

Action Number	Compliance	Comments
		Bill. The proposed road development will however support sustainable modes of transport through the provision of new pedestrian and cycle facilities and new bus lanes as part of the development. It also facilitates the further public transport, cycling and walking measures included in the overall GTS.
38	Neutral	The implementation of the proposed road development will not impact on the interdepartmental working group.
39	Neutral	The implementation of the proposed road development will not impact on the establishment of the National Sustainable Travel Office.
40	Neutral	The implementation of the proposed road development will not impact on the establishment of the Dublin Transportation Authority.
41	Neutral	The proposed road development will not impact on the strategy of the Dublin Transportation Authority.
42	Supportive	The proposed road development forms a key component of the overall GTS, which is developed to achieve sustainable travel and transport services in Galway City and environs. The proposed road development assists in modal shift through the provision of bus lanes and safe segregated pedestrian and cycle facilities connecting residential areas and employment areas.
43	Neutral	The proposed road development will not impact on the sustainable transport initiatives between Northern Ireland and the Republic of Ireland.
44	Supportive	The proposed road development will assist in delivering a modal shift of transport to more sustainable forms of transport through the provision of bus lanes and dedicated, safe routes for pedestrians and cyclists to access the employment centres, education centres and residential areas, whilst also alleviating congestion in Galway City Centre, affording the opportunity to further improve facilities for road based public transport and facilities for pedestrians and cyclists.
45	Supportive / Neutral	The proposed road development forms a key component of the GTS which has been presented to the elected members and staff of Galway City Council and Galway Council. The endorsement of the GTS by the elected members is the basis to implement the sustainable travel.
46	Neutral	The proposed road development will not impact on the introduction of branding to support the concept of smarter travel.
47	Neutral	The proposed road development will not impact on the introduction of fund to support innovative sustainable travel projects.
48	Supportive	The results of the National Travel, Transport and Mobility Household Survey 2012 were utilised in the development of the NTA Western Regional Model. This model was used for the multi-modal transport analysis undertaken for the proposed road development to ensure that the travel patterns in the off-peak periods are addressed in the model.

Action Number	Compliance	Comments
49	Neutral	The proposed road development will not have an impact on the biennial reporting on the progress of the Smarter Travel Policy.

2.3.3 Forfás Regional Competitiveness Agendas

Forfás was Ireland’s national policy advisory body for enterprise and science until 2014 when it was dissolved and integrated with the Department of Jobs, Enterprise and Innovation. Forfás' policy functions included the provision of independent and rigorous research, advice and support in the areas of enterprise and science policy. This work informed the Department of Enterprise, Trade and Employment and wider Government in its responses to the fast-changing needs of the global business environment.

In their suite of seven Regional Competitiveness Agendas (RCAs): *Overview, Findings & Actions of December 2009*, Forfás assessed how each region could strengthen its competitive environment in support of enterprise. The RCAs proposed specific actions to address barriers to development and focused efforts on realising the potential of each region. The N6 Galway City Outer Bypass (GCOB, 2006) is listed under Priority Actions for Physical Infrastructure in the West.

The additional Forfás publication of 2012, entitled *Overview of Main Infrastructure Issues for Enterprise*, was published post the publication of the Infrastructure and Capital Investment 2012-2016 (November 2011). It noted the need to develop smarter solutions to leverage the significant investments already made and improve our competitiveness and a *Galway ring road* is listed as a priority:

“Given the limited capital resources available in the short to medium term, it is critical that we prioritise investment that will support economic recovery and sustainable growth. These include the completion of the Cork and Galway ring roads and two short sections of the Atlantic Corridor (Galway - Limerick-Cork) which will improve the mobility of people and goods in and between Ireland’s main regional cities. Improving public transport in the main cities is critical to enhance mobility for all urban transport users.”

This was subsequently continued through to the *Building on Recovery: Infrastructure and Capital Investment Plan 2016-2021* produced by the department of Public Expenditure and Reform, as referenced above at **Section 2.3.1**.

The proposed road development is identified as a project at a national level which is necessary to support economic recovery and sustainable growth because of its ability to improve mobility of people and goods into and out of Galway, and is vital to the economic recovery of the Western Region as a whole. This is further detailed in **Chapter 3, Need for the Proposed Road Development**.

2.3.4 National Planning Framework

The National Planning Framework now represents the overarching national planning policy document, of direct relevance to the planning functions of regional and planning authorities, including An Bord Pleanála and from the 16 February 2018 it replaces the National Spatial Strategy (NSS).

The National Planning Framework (NPF), together with the new ten-year National Development Plan, are jointly named *Project Ireland 2040: Building Ireland's Future* and will provide the framework for future development and investment in Ireland. It is the overall Plan from which other, more detailed plans will take their lead, hence the title, National Planning 'Framework', including city and county development plans and regional strategies. The National Planning Framework will be a tool to assist the achievement of more effective regional development. The National Planning Framework also has statutory backing.

The National Planning Framework (NPF) focuses on ten strategic outcomes:

- Compact Growth
- Enhanced regional accessibility
- Strengthened Rural Economies and Communities
- Sustainable Mobility
- A strong economy, supported by Enterprise, Innovation and Skills
- High quality international connectivity
- Enhanced amenity and heritage
- Transition to a low carbon and climate resilient society
- Sustainable management of water and other environmental resources
- Access to quality childcare, education and health services.

(Ref: *Project Ireland 2040, Building Ireland's Future*).

The objectives of the NPF will be applied on a regional basis through statutory Regional Spatial and Economic Strategies (RSESs), see **Section 2.4.1.1** below. The RSESs must accord with the NPF and in turn, local authority development plans which address further detailed local matters, must be in accordance with the RSESs.

Section 2 of the NPF sets out the strategy to plan for population and economic growth. The NPF supports as a key element of the strategy "*ambitious growth targets to enable the four cities of Cork, Limerick, Galway and Waterford to each grow by at least 50% to 2040 and to enhance their significant potential to become cities of scale*." (NPF Section 2.2). It further sets national policy objectives arounds population and employment growth.

Section 3.3 of the NPF focuses on the Northern and Western Region. It focuses on Galway as one of the country's five main cities and as a key driver for the west of Ireland. The NPF states that Galway needs to "*address recent growth legacy issues and build on key strengths including a world class med-tech cluster, third level institutions embedded within the City, a vibrant arts and cultural scene, year round* *tourism and an attractive natural setting*". It states that *"challenges to be addressed include housing choice and affordability, transport / mobility and urban quality, especially outside the core-city centre area*". The NPF targets a population growth to 2040 of 40,000-45,000 people for Galway City and Suburbs, to achieve a total population of at least 120,000 total population (Table 2.1 NPF).

"*Key future growth enablers*" set out for Galway include:

- Progressing the sustainable development of new greenfield areas for housing and the development of supporting public transport and infrastructure, such as at Ardaun
- Improving sustainable transport links
- Provision of a Citywide public transport network (The National Development Plan 2018-2027 states that the Bus Connects network of five high performing cross-city routes will be delivered in Galway)
- Development of a strategic cycleway network
- Delivery of the Galway City Ring Road

"*Enhanced Regional Accessibility"* is one of the National Strategic Outcomes in the NPF. This seeks enhanced connectivity between centres of population and improved accessibility to the northern and western region, and seeks to advance orbital traffic management solutions including the proposed road development to achieve these objectives.

The National Development Plan 2018-2027 seeks the delivery of major national infrastructure projects in the interest of regional connectivity and names the N6 Galway City Ring Road as one such major project (Section 1.7 and 5.2).

The proposed road development is situated within this national planning framework as a key growth enabler for Galway City and the western region.

2.3.4.1 National Spatial Strategy 2002-2020

The National Spatial Strategy (NSS) 2002 to 2020 was a twenty-year national planning framework designed to deliver more balanced social, economic and physical development between regions. The NPF replaced the NSS on the 16 February 2018. The NPF builds on many of the objectives of the NSS particularly the strategy that the main cities and surrounding hinterlands of Cork, Galway, Limerick and Waterford can deliver more balanced growth to the regions, to counterbalance the growth of the Dublin region.

The NSS provided the policy framework for all regional and local plans, including the Regional Planning Guidelines for the West Region (referenced below), which are to be replaced by the Regional Spatial and Economic Strategies (RSES) for each of the three new regions of the Northern & Western Region (relevant to Galway), the Midland & Eastern Region, and the Southern Region, under the NPF In the absence of the RSES for the Northern and Western Region, it is considered that the framework which the NSS provides for the Regional Planning Guidelines for the West Region (see Section 2.4.1 below), and consequently for the Galway City and Galway County Development Plans, should be referenced. This is captured in **Plate**

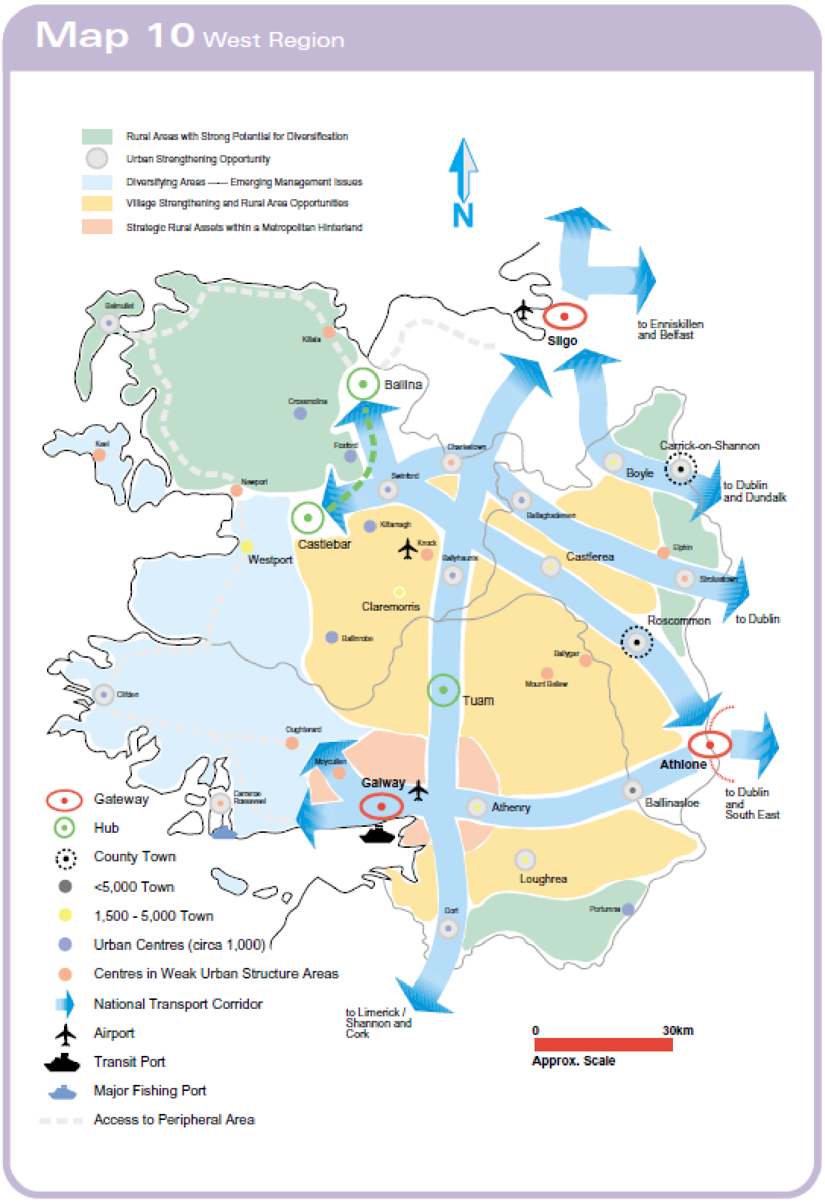
2.2 below which sets out the framework structure for the West Region in terms of urban-rural structure, transport connectivity, infrastructure provision etc. which has been reflected in the regional and city/county level plans. With regard to the proposed road development, this extract from the NSS shows the national transport corridor extending from the existing N6 on the east of Galway City across the River Corrib to the west of Galway in order to serve Connemara and Galway County.

The goal in all of the NSS was that this spatial restructuring would lead to:

- *strategically placed, national scale urban areas, acting as gateways, which individually and in combination will be key elements for delivering a more spatially balanced Ireland and driving development in their own regions*

(reference Section 3.1 of NSS).

Plate 2.2: National Spatial Strategy – West Region



2.3.5 Climate Change Act 2015

The Climate Action and Low Carbon Development Act 2015 provides for the establishment of a national framework with the aim of achieving a low-carbon, climate-resilient, and environmentally sustainable economy by 2050. The Act provides the tools and structures to transition towards a low-carbon economy and it anticipates that it will be achieved through a combination of:

- a national mitigation plan (to lower Ireland's level of greenhouse gas emissions)
- a national adaptation framework (to provide for responses to changes caused by climate change)
- tailored sectorial plans (to specify the adaptation measures to be taken by each Government ministry)

The Act obliges "relevant" bodies to have regard to the following factors in the performance of their functions:

- the most recent approved national mitigation plan
- the most recent approved national adaptation framework and approved sectorial adaptation plans
- the furtherance of the national transition objective
- the objective of mitigating greenhouse gas emissions and adapting to the effects of climate change in the State

The Act also provides for the establishment of an independent national expert advisory council on climate change which was formally established on 18 January 2016. The heads of the Environmental Protection Agency, the Sustainable Energy Authority of Ireland, Teagasc and the Economic and Social Research Institute are members of the Advisory Council.

The functions of the Advisory Council are to advise and make recommendations to the Minister and the Government in relation to matters such as the preparation of a national mitigation plan, a national adaptation framework, a sectoral adaptation plan, or any policy that is proposed to be submitted to the Government for approval in relation to the reduction of greenhouse gas emissions and adaptation to the effects of climate change in the State.

The Advisory Council is required to conduct an annual review of the progress made during the previous year in achieving greenhouse gas emissions reductions and furthering a transition to a low-carbon, climate-resilient and environmentally sustainable economy. The Advisory Council is to produce an annual report on its findings and recommendations stemming from its annual review.

The proposed road development supports the principles of the Climate Action and Low Carbon Development Act 2015 in so far as it provides the necessary strategic infrastructure which has sufficient capacity to cater for the traffic needs of Galway and its environs which in turn reduces bottle necks and congestion within the city itself, even allowing for any increased traffic generated by the proposed road development. The proposed road development with the GTS measures in place results in a 16% increase in modal shift to public transport at Design Year when compared with the Do Minimum scenario, i.e. the non-scheme scenario. Essentially this means that vehicle trips are removed from the existing traffic and these passengers become public transport users, all of which is a benefit to reducing emissions. Every shift, however small, from the private vehicle to public transport or walking or cycling is a positive and is a gain in terms of climate action. Therefore, as the proposed road development facilitates the effective implementation of the Galway Transport Strategy it is supporting the principles of the Climate Action and Low Carbon Development Act 2015, even allowing for any increased traffic generated by the proposed road development.

An appraisal of the proposed road development under the heading of Climate is included in **Chapter 16, Air Quality and Climate**.

2.3.6 National Mitigation Plan 2017

The first National Mitigation Plan was published in July 2017 by the Department of Communications, Climate Action and Environment. The Plan is designed to be a whole-of-Government approach to tackling greenhouse gas emissions, particularly, in the key sectors i.e. electricity generation, the built environment, transport and agriculture. The objective of this Plan is to transition Ireland to a low carbon, climate resilient and environmentally sustainable economy by 2050.

The National Mitigation Plan recognises the inter-relationship between settlement patterns, transport and land use planning, and seeks solutions to effectively meeting travel demand in a manner that avoids congestion and limits transport emissions.

As set out in **Section 2.3.5** above the proposed road development facilitates the effective implementation of the Galway Transport Strategy and in doing so it is supporting the principles of the National Mitigation Plan, even allowing for any increased traffic generated by the proposed road development.

An appraisal of the proposed road development under the heading of Climate is included in **Chapter 16, Air Quality and Climate**.

2.3.7 National Action Plan for Social Inclusion (2007-2016) and Update 2015-2017

The National Action Plan for Social Inclusion 2007 – 2016 (NAPinclusion) identified a wide range of targeted actions and interventions to achieve the overall objective of reducing consistent poverty.

The plan prioritised 12 high level goals and identified up to 150 actions across Departments and agencies with a remit in social policy, as part of a strategic approach to make a decisive impact on poverty over the period to 2016.

Relevant goals and actions set out in the NAP inclusion which reference improved accessibility for all sectors of the community, include improvements to public transport (section 3.1 Vision), improved access to public transport (section 5.6.3, Section 4.1 Vision, Section 5.1 Vision), access to buildings and infrastructure (section 5.6.2), improvements to rural transport provision (section 6.3.7).

As a result of dynamics in economic, social and political contexts, certain NAPinclusion goals and actions became out of date or less relevant. Current priorities and policies indicated that updating of NAPinclusion for its remaining two years 2015-2016 was required and an extension of one year to the Plan to coincide with other related Strategy reviews at Government level. This updating process was carried out as a transitional measure pending a full review of NAPinclusion in 2017.

The proposed road development will provide the necessary infrastructure for strategic traffic accessing Galway and the Western Region. It will also enable other public projects be realised and facilitates the effective implementation of the Galway Transport Strategy which includes improved public transport, walking and cycling measures for Galway City and its environs. This is further detailed in **Chapter 3, Need for the Proposed Road Development**.

2.4 Regional Policies, Guidance and Objectives

2.4.1 Regional Planning Guidelines (RPGs) for the West Region (2010-2022)

The *Regional Planning Guidelines (RPGs) for the West Region 2010 – 2022* (adopted 2010) set out the planned direction for growth for the West Region, within which Galway County and City is located, up to 2022 by giving regional effect to national planning policy under the National Spatial Strategy (NSS). The RPGs inform and direct the City and County Development Plans of each of the Councils in the West Region, comprising Galway City and Galway County, Roscommon, Mayo.

The RPGs recognise that the West Region has a significant and valuable resource in its natural heritage environment with a wide variety of species and habitats of local, national and international importance, the extent of which enhances the quality of life but also represents a real challenge in achieving sustainable development.

The RPGs acknowledge that the West Region has experienced difficulties in the past due to its peripheral location along the Atlantic seaboard and on the periphery of the EU. For the West Region to achieve critical mass and growth and ultimately offer an alternative development corridor to the east coast corridor, strong communication links are required to achieve this through well-developed road, rail and air links as they are key stimuli for 'corridor' growth.

Section 3.5.2 of the RPGs, sets out specifically the need for a reduction in transport costs by improving the road networks particularly the *M6 and potential Galway Outer Bypass* as part of the economic development of the region. Section 5.2.1 of the RPGs outlines the necessary road priorities for the Region, including the *Galway City Outer Bypass*.

As outlined above, the proposed road development is necessary to support economic recovery and sustainable growth of the Western Region as a whole which is of overriding public interest at a national level as the country moves towards sustainable growth and recovery.

2.4.1.1 New Regional Assemblies

Three new Regional Assemblies came into being on 1 January 2015, namely the Northern & Western (relevant to Galway), the Midland & Eastern and the Southern Regional Assemblies, following on from the enactment of the Local Government Reform Act 2014 and Putting People first – Action Programme for Effective Local Government. Galway and the West Region has been subsumed into the Northern & Western Regional Assembly.

At the same time as the publication of the draft National Planning Framework in November 2017, three Regional Assemblies of all 31 local authorities across the country began the preparation of new Regional Spatial and Economic Strategies (RSESs), framed in the light of the NPF but extending its approach at more detailed levels to shape local planning and economic development in each local authority area.

Each Regional Assembly published an Issues Paper for public consultation (submissions made by 16 February 2018). Key spatial and economic issues to be addressed are set out in the Northern & Western Regional Assembly (NWRA) Issues Paper, with reference to the National Planning Framework. These include issues such as location of development, provision of infrastructure including transportation, provision of educational and healthcare facilities, economic development and regional economic performance.

A key focus for the RSES will be the preparation of a co-ordinated Metropolitan Area Strategic Plan (MASP) for Galway (and potentially for other identified urban locations). The MASP will be provided with "*statutory underpinning to act as twelve-year strategic planning and investment frameworks for the city metropolitan areas*". The purpose of the MASP will be "*to provide high level long term strategic development focus on areas such as the identification of strategic growth areas, infrastructure (particularly transport and water services), regeneration, the location of housing and employment and metropolitan scale amenities such as regional parks and cycle networks.*" (see section 2.1.1 of the NWRA Issues Paper).

The RSES also seeks to enhance regional performance by identifying regional strengths and opportunities and identifies the Region's strong employment base, both multi-national operations and SMEs, and the Region's strong educational base, (NUIG identified as ranked in the top 1% of global universities). It also identifies the Region's "*internationally important environmental assets*", and the "*desire to protect these assets for the value they contribute*" to the lifestyle and economy of the Region (acknowledged as important to tourism), as well as for their intrinsic value (see sections 3,4, and 5 of the Issues Paper).

Among the "Critical Enabling Infrastructural priorities" for the Region identified by the NWRA as being "*crucial to the ability*" of the major urban centre's to harness potential and "*act as Regional drivers*" are the completion of the N6 Galway City

Ring Road, and the full implementation of the Galway Transportation Strategy (see section 6.3 of the Issues Paper).

The NWRA Issues Paper recognises the proposed road development as critical to the spatial and economic success of the Region.

2.5 Local Policies, Guidance and Objectives

The proposed road development passes through two local authority areas – Galway City Council and Galway County Council.

Both Galway City and County Councils are committed to intensifying public transport delivery and usage to deliver growth and improve quality of life in Galway. Both the Galway City Development Plan 2017-2023 and Galway County Development Plan 2015-2021 support the proposed N6 GCRR as part of the GTS which is the overall transport strategy.

2.5.1 Galway Transport Strategy (GTS) 2016

Galway City Council and Galway County Council, in partnership with the National Transport Authority (NTA), prepared a Galway Transport Strategy which aims to address the current and future transport requirements of Galway City and its environs, including Bearna, Oranmore, Moycullen and Claregalway. The NTA are the national body responsible for public transport and are fully committed to the delivery of a sustainable transport solution for Galway City and its environs. As Galway City and its environs continue to develop as the principal economic centre serving the West of Ireland, there is a critical need to address the transportation issues facing the city and surrounding areas, and to underpin future growth by establishing a long-term strategy for transport to, across, within and around the city.

While Galway has a compact walkable core, outside of the city centre, the suburbs have developed as a succession of low density residential and employment areas, which has led to a predominance of private car usage as a means of travel. As a result, the transport difficulties currently experienced across the city, particularly at peak travel times, are having a significant effect on the quality of life of residents, and are also impacting on the economic functionality of the city.

The Galway Transport Strategy (GTS) consists of a number of proposed measures combined under an overall vision "*to create a connected city region driven by smarter mobility*". The GTS builds on previous transport studies carried out for the Galway Region, and sets out an overview of the proposed actions and measures for implementation, covering infrastructural, operational and policy elements (as an 'Integrated Transport Management Programme'). These consolidated proposals will provide Galway City and its environs with a clear implementation framework over the next 20 years and will be used to secure funding to deliver projects in a phased manner based on priority needs. Ultimately, the GTS will underpin the objectives of the current and future Galway City and Galway County Development Plans.

The major components proposed under the GTS comprise:

- changes to the traffic network, including provision of a new cross-city link public transport corridor, and the N6 Galway City Ring Road (the proposed road development), and reallocation of road space to prioritise walking, cycling, public transport
- an enhanced local public transport network and regional public transport service focused on an enhanced, integrated high quality bus service
- provision of the Bearna Greenway, the Galway City to Oranmore Cycleway (part of the Galway to Dublin Cycleway) and the Galway to Oughterard Greenway
- a range of other additional cycling, pedestrian and public realm improvements including increased options for cycling in and across the city centre, improved pedestrian facilities, pedestrian prioritisation and way finding and legibility
- complementary measures including education and behavioural change measures and continued investment in Intelligent Transport Solutions (ITS) to increase efficiency, safety and co-ordination across transport networks (Smarter Mobility), and further emphasis on land use and transport integration

The proposed road development represents a key element of the GTS in planning for the future transport requirements of Galway City and its environs. The GTS, incorporating the N6 GCCR, will allow the city to 'breathe' again.

It provides an additional crossing of the River Corrib, thus facilitating the reduction of congestion on city centre roads, and allows the reallocation of road space in the city network to non-private car modes of transport, thereby improving the attractiveness of non-car modes of transport in the city for short and medium distances. This is further detailed in **Chapter 3, Need for the Proposed Road Development**.

2.5.2 Galway City Council

2.5.2.1 Galway City Development Plan 2017-2023

The Galway City Development Plan 2017-2023 as varied, hereafter referred to as the City Development Plan, sets out Galway City Council's policies for the sustainable development of Galway City to 2023. It establishes the vision for Galway City "*to be a successful, sustainable, competitive, regional centre that creates prosperity, supports a high quality of life and maintains its distinctive identity and supports a rich cultural experience*."

The strategic goals for the city to realise this vision are set out as:

1. Achieve a high quality of life for all citizens through the provision of a good quality, attractive, built environment, through the protection of the unique natural environment and through facilitation of key economic, cultural and social supports
2. Enable the city to fulfil its role as a National Gateway, a Regional centre and contribute to the economic recovery through the provision of balanced and sustainable economic opportunities for growth, innovation and investment

across all employment sectors and allow the role of the Gateway to harness the strengths and maximise the economic development for the whole West Region

3. Promote the reduction of greenhouse gas emissions through proactive measures in line with EU commitments to tackle climate change and reduce vulnerability to the harmful effects of climate change, in particular sea level encroachment and extreme weather events, through specific adaptation measures
4. Apply the principle of sustainability particularly where it relates to the uses of land, buildings, water, energy, waste and through the encouragement of sustainable modes of transport and the integration of transportation with land use
5. Aspire to make Galway an equal and inclusive city, particularly through facilitating all forms of social inclusion in the built environment, including in the public realm, housing, community facilities, in access to employment opportunities and public transportation
6. Protect the distinctive and diverse natural environment in the city and strengthen the green network and linkages, recognising the biodiversity value of the amenity, the range of recreational benefits this provides, the potential through facilitating active and healthy lifestyles, it can have on the quality of general health and well-being and the value it has for providing an attractive city setting
7. Encourage a sense of collective identity and a shared vision through civic engagement on projects such as the development of a Local Economic and Community Plan for Galway and also on the promotion of specifically focused projects such as the European Capital of Culture 2020, that will promote the unique form and character of the city, give opportunities for the development of cultural, community and other beneficial infrastructure and enhance and diversity the city economy (Galway City secured the European Capital of Culture 2020 designation in July 2016)

The City Development Plan's Core Strategy includes for Galway to continue to be the regional growth centre and to create the synergies for wider prosperity in the West Region. It focuses on the development of key regeneration locations in the city centre to reinforce the "*prime role of the city centre in both Galway City and the Gateway Region*". The Strategy focuses a significant amount of new residential development and population growth in the Ardaun area of the city (see **Section 2.5.2.2** below), while acknowledging that "*other residential areas of the city will grow but at a more constrained rate and in character with the established nature of development*". It designates the key centres of commercial, retail and local community activities are located "*to co-ordinate with the prime role of the city centre*". (Section 1.4 Galway City Development Plan).

The Core Strategy is further supported and informed by the Galway Transport Strategy (GTS) set out in **Section 2.5.1** above.

The transport strategy for the city in the City Development Plan aims "*to integrate sustainable land use and transportation, facilitating access and choice to a range* *of transport modes, accessible to all sections of the community that ensures safety and ease of movement to and within the city and onward connectivity to the wider area of County Galway and the West Region*." The City Development Plan notes that while the implementation of various measures stemming from the Galway Transport Unit have made improvements to the transport network, "..*serious traffic congestion still prevails which impacts on peoples' quality of life and the economy of the city, and the regional role of Galway as Gateway*".

The City Development Plan sets out that these issues have now been assessed in the preparation of the Galway Transport Strategy 2016 (see **Section 2.5.1** above), prepared by Galway City Council and Galway County Council in partnership with the NTA.

In this regard, the City Development Plan incorporates Policy 3.3 Galway Transport Strategy (GTS) which aims to "*Continue to progress a sustainable transport solution for the city through the implementation of measures included in the GTS and required supporting projects in particular the N6 GCRR project*".

The City Development Plan furthermore, incorporates the GTS through other policies and provisions including Policy 3.2 Land Use and Transportation;

"Facilitate the future development of Galway City and environs within the strategic framework of the Galway Transport Strategy and the associated implementation phasing to ensure that the city has the necessary transport infrastructure and services to support its continued growth and development."

Other policies in the Plan that integrate the GTS with City objectives are:

- Policy 3.4 Traffic Network, which specifically references the N6 Galway City Ring Road (GCRR) project by "…supporting the reservation of a corridor route to accommodate an orbital route as provided for in the N6 GCRR project."
- Policy 3.5 Public Transport
- Policy 3.6 Cycling and Walking
- Policy 3.7 Road and Street Network and Accessibility, which also specifically supports the N6 GCRR
- Policy 3.10 Specific Objectives emphasises the principles and objectives of the GTS, with specific reference to the N6 GCRR
- Economic Activities (Chapter 5) Strategy which incorporates specific reference to the delivery of the GTS and the N6 GCRR, to "Enhance the economic performance of Galway as a Gateway and regional growth centre..."
- Policy 5.1 Enterprise supports the "…implementation of the phased plan of transportation measures as proposed for in the Galway Transport Strategy (GTS) including for public transport, walking and cycling, and a strategic new road, the N6 GCRR"
- Section 8.7 Urban Design Public Realm incorporates principles and objectives of the GTS in relation to improving the quality and experience of the public realm and city environment

- Chapter 10 City Centre/Area Based Plans reflect the principles and objectives of the GTS, including the delivery of the proposed N6 GCRR, and resulting potential for city centre wide improvements to public realm and urban environment, and improved pedestrian and cycle facilities, networks and linkages
- Chapter 11 Land Use Zoning Policies and Objectives, Section 11.2 Land Use Zoning General states that "Priority will be given to the reservation of the N6 GCRR Preferred Route Corridor and the associated land requirements over other land use zonings and specific objectives"

The overall Transport Strategy of the City Development Plan is to:

- Support and facilitate the integration of land use and transportation
- Support the Galway Transport Strategy (GTS) and the associated implementation programme which will deliver a high quality public transport network, and encourage the use of other sustainable modes of transport
- Support the proposed road development in conjunction with Galway County Council and Transport Infrastructure Ireland in order to develop a transportation solution to address the existing congestion on the road network and reduce the negative impact of vehicular traffic on the functioning and experience of the city centre and to facilitate city bound, cross-city, cross-county and strategic east-west movements
- Support the reduction in greenhouse gas emissions through the promotion of sustainable land use and transportation

The Galway City Development Plan 2017-2023 fully integrates the aims, objectives, and strategies of the GTS into core policies and strategies, which includes the proposed road development.

2.5.2.2 Ardaun Local Area Plan 2018-2024

Galway City Council has prepared a Draft Local Area Plan (LAP) for lands situated at the area known as Ardaun on the east side of the city (164ha), approximately 5km from the city centre. The Draft LAP was subject to a public consultation period from 7 September to 20 October 2017. It was further subject to material alterations, which were put to public consultation during January-February 2018 and adopted in April 2018.

The Core Strategy of the Galway City Development Plan 2017-2023 identifies Ardaun "*as a key development area that can accommodate long term growth in population, economic activity and employment opportunities*" (Section 1.1 Ardaun LAP), and the preparation of a LAP for the area is a specific objective of the Development Plan (Policy 8.7). This supports regional planning policy where the "*West Regional Planning Guidelines 2010-2020 consider Ardaun as the most optimal area for growth in the city and environs*" (LAP 1.3).

The LAP seeks to deliver the concept of an urban village, with the principal urban village centre in the southern section of Ardaun i.e. south of the N6/M6 corridor, with two urban nodes / local centres north of this corridor, linking to surrounding areas including the existing Coolagh Village. It is anticipated that the area can support a population of over 8,000 people and also function as a mixed use business and retail district (LAP Section 1.2).

Strategic Goal 4 of the LAP (Section 3) supports the development of sustainable transport modes as proposed in the Galway City Development Plan and the Galway Transport Strategy. This Strategic Goal is further supported by the policy to "*Promote interconnectivity between all modes of transport, in particular sustainable and public transport modes in order to efficiently link Ardaun with the main hubs for activity including the city centre in accordance with the GTS*". This is further supported in Section 4.5 of the LAP by a key objective to "*Support and facilitate the provision of an integrated public transport network to service Ardaun through the implementation of the Galway Transport Strategy and in conjunction with relevant transport providers, NTA and other stakeholders*."

This LAP reserves the preferred route corridor of the proposed road development as it traverses the LAP area, as per Galway City Development Plan objectives, Section 1.4 and Section 3.10.

The development strategy of the LAP acknowledges and aligns with the Galway City Development Plan, the Galway Transport Strategy, and the proposed road development.

2.5.3 Galway County Council

2.5.3.1 Galway County Development Plan 2015-2021

The Galway County Council Development Plan (2015-2021) which includes a Variation to incorporate GTS, hereafter referred to as the County Development Plan, sets out the aspirations for Galway County within its lifetime and the near future. As noted in the background to the plan, it aims to "*sets out an overall strategy for the proper planning and sustainable development of the functional area of Galway County Council*". With reference to local, regional, national and European policies the plan sets out the main strategies for the County in the areas of:

- Spatial Strategy, Core & Settlement Strategy, including for development of lands at Ardaun as part of the City and County development strategy
- Urban & Rural Housing
- Economic Tourism & Retail Development
- Roads & Transportation
- Water, Wastewater, Waste Management & Extractive Industry
- Energy/Renewable Energies & Communications Technology
- Climate Change & Flooding
- Heritage, Landscape & Environmental Management
- Cultural, Social & Community Development
- Agriculture, Fishing, Marine Resources & Forestry

The County Development Plan further sets out its vision for the County which is to "*enhance the quality of life of the people of Galway and maintain the County as a uniquely attractive place in which to live, work, invest and visit, harnessing the potential of the County's competitive advantages in a sustainable and environmentally sensitive manner*."

The strategic aims of the County Development Plan (Refer to Section 1.7) include:

1. Promote regional development and growth through harnessing the competitive advantages of County Galway
2. Afford suitable protection to the environment
3. Recognise the importance of living landscapes while ensuring they are managed in a sustainable and appropriate manner
4. Seek balanced urban and rural development
5. Encourage and support the development of inclusive communities
6. Ensure integrated development
7. Promote sustainable mobility
8. Promote An Ghaeltacht as an Irish speaking community
9. Facilitate the development of infrastructural projects which will underpin sustainable development
10. Enhance and protect the built heritage and natural environment
11. Integrate climate change consideration in planning and delivering work programmes

The principle of sustainable development is a major component of the County Development Plan which is reflected in the Plan's policies and objectives. The Core Strategy in the County Development Plan is supported and informed by the GTS.

The Galway County Development Plan 2015-2021 retains the objectives of the previous County Development Plan to provide a solution to congestion, to provide better connection from all parts of the County to the trans-national network, and to improve safety levels on all public roads. "*The integration of land use and transportation shall continue to be the overarching strategic aim of the Galway County Development plan 2015-2021*" (Refer Section 5.1).

The County Development Plan further states that "*the timely provision of high quality transportation infrastructure within County Galway is critical to the County's socio-economic development and in the promotion of social and economic well-being*". (Refer Section 5.1).

The County Development Plan transportation objectives (Section 5.1.1) include the following strategic aims among others:

- *"To provide a safe and efficient network of transport to serve the needs of the people and the movement of goods and services to and within County Galway*
- *Provide access for all in an integrated manner with an enhanced choice of transport options including the Rural Transport Programme*

- *To promote and encourage the use of alternative sustainable modes of transport and to promote the use of transport energy from renewable resources*
- *To safeguard the strategic transport function and carrying capacity of the motorway and national road network and associated junctions in order to provide for the safe and efficient movement of inter-urban and inter-regional traffic"*

In relation to the Galway Gateway and west of the County, the County Development Plan incorporates objectives to enhance connectivity and access across the region, and to deliver on the transportation needs of the Galway Gateway, its environs and the west of the County, as per Policy TI2 and TI8 and Objective TI 15, as follows:

Policy TI 2 – Development of an Integrated and Sustainable Transport System

It is the policy of the Council to promote the development of an integrated and sustainable high quality transport system for the county, which includes the specific areas identified in the Galway Transport Strategy (GTS), which shall:

a) Promote closer co-ordination between land use and sustainable transportation;

b) Continue the provision of a range of transport options within Galway and in collaboration with Galway City Council, the National Transport Authority (NTA), Transport Infrastructure Ireland(TII), other statutory agencies and transport providers, including safe road network, a range of bus and rail services, adequate facilities for walking and cycling and opportunities of air and water-based travel.

Policy TI 8 –Transportation Infrastructure Requirements for the Gateway and West of the County

It is the policy of Galway County Council to work with Galway City Council and all relevant statutory bodies including the National Transport Authority (NTA) and Transport Infrastructure Ireland (TII) to deliver an appropriate infrastructural response to the transportation needs of the Galway Gateway, its environs and the west of the County as part of the proposed measures of the Galway Transport Strategy (GTS) including the plan level environmental protection policies and mitigation measures set out in the GTS. This shall include the provision of new infrastructure such as potential park and ride facilities, bus corridors, greenways, cycling and walking routes and the N6 Galway City Ring Road (GCRR) which are all integral in the delivery of the GTS with a view to relieving congestion, improving travel times, increased safety of all road users and enhancing connectivity and access within the region and enhanced accessibility of the western region in a national and international context. Any such solution shall have due regard to the necessity to protect the environment and will comply fully with the requirements of the Habitats Directive

Objective TI 1 – Sustainable Transportation

Support and facilitate 'Smarter Travel' initiatives contained in the Galway Transport Strategy (GTS) and other initiatives together with the plan level environmental protection policies and mitigation measures set out in the GTS, which will improve sustainable transportation within the County including public *transport, electric and hybrid vehicles, car clubs, public bike schemes, park and ride/park and stride facilities, improved pedestrian and cycling facilities, as appropriate.*

Objective TI 15 - Transportation Infrastructure Requirements for the Gateway and West of the County

It is an objective of Galway County Council to work with all other relevant bodies including the National Transport Authority (NTA), Transport Infrastructure Ireland (TII) and Galway City Council to deliver the necessary improvements to transportation infrastructure, including new infrastructure if necessary and the plan level environmental protection policies and mitigation measures set out in the GTS. This shall include the provision of new infrastructure such as potential park and ride facilities, bus corridors, greenways, cycling and walking routes and the N6 Galway City Ring Road (GCRR) as set out in the Priority Transportation Infrastructure Objectives 2015-2021 in Table 5.1 which are all integral in the delivery of the GTS with a view to secure the medium and long term economic and social development of Galway Gateway and the west of the County. Any such investment or project shall be carried out with due regard to the necessity to protect the environment and in full compliance with the provision of relevant legislation, including the Habitats Directive

The performance targets of the proposed road development align with the strategic aims of the County Development Plan as they include the following targets:

- Reduction of journey times which will promote regional development through improved connectivity to markets and journey time reliability
- Improve connectivity to the Gateway of Galway by providing high capacity linkages connecting east and west sides of the county
- Support sustainable transport policies for shorter commutes which will enable delivery of improved living landscapes
- Protection of existing residential communities and minimise environmental impacts which could make Galway a uniquely attractive place in which to live, work, invest and visit, in a sustainable and environmentally sensitive manner

The proposed road development is included as one of the priority transport infrastructure objectives in the County Development Plan and is fully supported by this plan.

2.5.3.2 Bearna Local Area Plan 2007-2017 (Adopted 17 December 2007 and Amended 20 December 2012)

The Bearna Local Area Plan (LAP) sets out a Strategic Vision for Bearna to be '*…an attractive, prosperous and sustainable settlement with a hiqh quality built and natural environment, a range of supporting services, facilities and amenities and a high quality of life for the local community*.' It also promotes the creation of a settlement that, *inter alia*:

- Is well connected to, but has strong local identity separate from, nearby settlements, in particular Galway City to the east and Na Forbacha to the west
- Has an appropriate level of services and infrastructure to support existing and future development in a manner that protects and is complementary to the environment, heritage, character and amenities of the village, including: an adequate road network, traffic management and parking facilities; improved public transport with regular bus services; safe routes for pedestrians and cyclists; and adequate wastewater disposal, water supply and surface water drainage

The Bearna LAP at Section 2.7 supports a new road that would bypass the village, with the stated view that it would have '*…..a positive impact for Bearna in that it will facilitate easy access to and from Bearna while reducing the volume of through traffic in the village. This would have a positive impact on the village centre and would help to create a more cycle and pedestrian friendly environment'*.

The Development Strategy of the Bearna LAP clearly sets out that it supports the funding and construction of a bypass of Bearna which now takes the form of this proposed road development.

The Galway County Development Plan was varied to incorporate the Bearna Local Area Plan. Public consultation on the variation, referenced as Proposed Variation No 2(a) to the Galway County Development Plan (CDP) 2015-2021, was sought during the period 1 December 2017 to 8 January 2018. This Variation was adopted in July 2018.

The Variation No. 2(a) Bearna Plan, has, as its Strategic Vision at Section 1.2, to seek "*the achievement of the overall objectives set out for the village in the Galway County Development Plan*". Transportation and Movement Objectives set out in the Variation, refers to Chapter 5 of the Galway County Development Plan, as set out in **Section 2.5.3.1** above. It has, as its Strategic Vision Statement "*'To promote Bearna as a sustainable and vibrant coastal village, which maintains its attractive character, capitalises on its existing and future accessibility strengths, while offering a pleasant environment for a growing community, for living, shopping, education, business, recreation and tourism, all balanced against the need to safeguard and enhance the environmental sensitivities of the area, for present and future generations to come'*. This is informed by guiding principles, which carry forward those of the Bearna LAP.

This Variation, therefore endorses the overall objectives of the Galway County Development Plan, and consequently the objectives of the GTS and this proposed road development.

2.5.3.3 Gaeltacht Local Area Plan, 2008 – 2018

Gaeltacht Na Gaillimhe is the most populous of the Country's Gaeltacht areas. It stretches from Claregalway, which is east of the city of Galway to Cloch na Rón in west Connemara, a distance of approximately 100km, and from Oileáin Árainn northwards to the Mayo border. The Gaeltacht Local Area Plan, 2008–2018 was prepared and adopted in February 2008 and amended and extended in 2013.

The purpose of the plan is to put in place controls and guidelines, consistent and compatible with the Galway County Development Plan, to facilitate the provision of infrastructure so that the younger generations will be encouraged to remain in their native area, out of choice, and develop its economy in a way that is both language and culture friendly, thus halting the decline in population. The Gaeltacht Local Area Plan sets out the strategic development principles relating to roads and transport infrastructure in **Section 3.3.2** and identifies a bypass of Galway City as being of importance to advancing the development of the social and economic advantage of the Gaeltacht and developing an integrated approach to planning.

The aims of the proposed road development align with this Gaeltacht Local Area Plan as it seeks to provide the necessary additional infrastructure to maintain existing rural communities by providing connectivity to them.

The Galway County Development Plan was varied to incorporate the Gaeltacht Local Area Plan. Public consultation on the proposed variation, referenced as Proposed Variation No 2(b) to the Galway County Development Plan (CDP) 2015-2021, was sought during the period 1 December 2017 to 8 January 2018. This Variation was adopted in May2018.

The Variation No. 2(b) Gaeltacht, has, at its Strategic Vision at Section 1.2, "*The Gaeltacht area is a unique and special place, and it is important that it retains that distinctive cultural heritage and natural beauty through the principles of sustainable development, whilst meeting the needs and aspirations of both the residents' and visitors alike. Achieving the objectives of the Galway County Development Plan in order to sustain and develop the local economy and improve the quality of life for local residents*."

This Variation supports the County Development Plan, and its objectives, which include the proposed road development.

2.5.4 Údarás na Gaeltacht Strategic Plan, 2014 - 2017

The main strategic themes of Údarás na Gaeltachta's Strategic Plan 2014 - 2017 are:

1. Support and develop language, community and cultural resources
2. Enhance innovation and competitiveness through the development of enterprise and natural resources

The Plan has four key objectives under each strategic theme set out above, of which the objectives pertaining to the second theme of innovation and competitiveness are most pertinent here:

1. Encourage a strong innovative enterprise culture which will create and sustain wealth and employment in the Gaeltacht by supporting new and established businesses to maintain and increase their employment
2. Develop new opportunities for the Gaeltacht's coastal resources through innovation in a changing economic environment

3. Stimulate the development of tourism as a driver of economic development in the Gaeltacht
4. Facilitate the provision of essential infrastructure in order to expand the enterprise capacity of the Gaeltacht

As the proposed road development seeks to deliver essential infrastructure to the western region, it aligns with the Údarás na Gaeltacht Strategic Plan.

2.6 Conclusion

As outlined in **this chapter**, the proposed road development is congruent with current European, national, regional and local transport policy and planning policy as set out in the various policy documents over the past number of years.

In recent years, there has been a major shift towards sustainable transport which is reflected in the policies discussed earlier. The changing demographics in our society whereby population is migrating to cities to avail of employment opportunities, education and improved living conditions necessitates the promotion of a wholly sustainable transportation network. Our cities are undergoing fundamental change as they strive to become living spaces for an increased population which is concentrated in a smaller tighter space. Key to a thriving urban experience is the ability to navigate a city at leisure whether as a pedestrian, a cyclist, or in a vehicle. Therefore, congestion relief through reallocation of the provision of space for cars in the city centre to other modes of transport, is key to creating more people friendly environments, additional public space, and essentially better cities.

The proposed road development functions to relieve congestion in the city. It is a key component of the Galway Transport Strategy which seeks to create a vision for Galway whereby additional space is reallocated for public transport, cycling and walking in the city centre area, all of which fosters sustainable and healthy behaviours. Reducing congestion also allows the city to prosper and connect with markets to become a thriving economic centre, in which it is attractive to work, live and play. Such a city in turn supports the Western Region and provides balanced regional development. The GTS, incorporating the N6 GCCR, will allow the city to ‘breathe’ again.

2.7 References

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3 Need for the Proposed Road Development

3.1 Introduction

This chapter of the EIAR outlines the need for the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development.

The need for the proposed road development arises directly from the necessity to address the very serious transport issues facing Galway City and its environs. A transport solution has been developed and the proposed road development forms an essential part of this solution.

The existing transport issues currently facing Galway City and its environs is presented in **Section 3.2** below. The overall objectives of the proposed road development are presented in **Section 3.3**. The development of the transport solution is outlined in **Section 3.4** with the specific project need is defined in terms of its strategic fit and priority within the National Road Programme in **Section 3.5**. Its potential to solve existing transport issues in Galway City and its environs, its function as part of TEN-T network and the specific need in terms of economy, safety, physical activity, environmental, accessibility and social inclusion and integration is detailed in **Section 3.6** and **3.7** with an overall need for the proposed road development and the benefits it offers outlined in **Section 3.8**.

3.2 Galway Transport Issues

The total breakdown of the existing transport network in Galway occurs on a frequent basis as there is no resilience in the network e.g. wet afternoon, road maintenance, vehicle collision and/or signal outage. This random unpredictable shutdown of Galway's transport network costs millions and has the real potential to prohibit Galway functioning as a city or economic engine for the Western Region.

The transport issues facing Galway City and its environs as a result of the inadequacy of the existing road network are wide ranging with associated consequential impacts as noted below:

- Congestion throughout the city road network
- Over capacity of existing junctions
- Journey time unreliability due to uncertain quantum of delay
- Journey time variability throughout the day
- Peak hour traffic delays
- By-passable traffic is in conflict with internal traffic
- Strategic traffic is in conflict with local traffic
- Inadequate transport links to access markets within the city
- Inadequate transport connections from Galway onwards to Connemara

- Lack of accessibility to the Western Region as a whole
- Prolonged journey times and delays on the current bus network, due in part to the limited available road space in the city centre for introducing bus priority which both reduces its attractiveness to passengers and increases costs of operating
- Limited road space on most of the principal roads, which reduces opportunities for safe and comfortable cycling
- Connectivity issues on the National and Regional road network resulting in significant volumes of cross-county and strategic travel demand between east and west Galway being concentrated and funnelled through the city area in order to cross the River Corrib
- The impact of traffic congestion on the city’s reputation, particularly with regard to inward development
- Accessibility issues due to traffic congestion for businesses and community facilities in Galway City and its environs and the Business Parks in Parkmore and Ballybrit
- The routing of thousands of vehicles per day through the city centre brings with it associated and unmitigated impacts on businesses, public facilities, homes and non-motorised road users
- The stop/start nature of urban driving and platooning of vehicles behind slow moving vehicles adds to the levels of pollution experienced by locals and visitors
- Severance effects of traffic congestion is experienced in urban areas and traffic speeds are increasing in rural areas as local roads are used to avoid the congested national road network

There is a critical need to address the transport issues in Galway City and its environs. As a Gateway to the Connemara and the Western Region, **connectivity and accessibility to and through Galway City** is essential in aiding the region to revitalise, improve and develop into the future. As Galway City and its environs continues to grow, it is crucial to **safeguard the future development** of the city as the principal economic centre in the west of Ireland and to ensure that its development is sustainable. In addition, providing **well developed transport links** via roads, rail and air to the Western Region enables enterprises and the local economy of the west to grow and develop as a viable alternative to the east coast corridor which is of significant public interest at a national level. The existing road network is analysed to establish the underlying issues so that the appropriate transport solution is implemented.

3.2.1 Overview of Existing Road Network

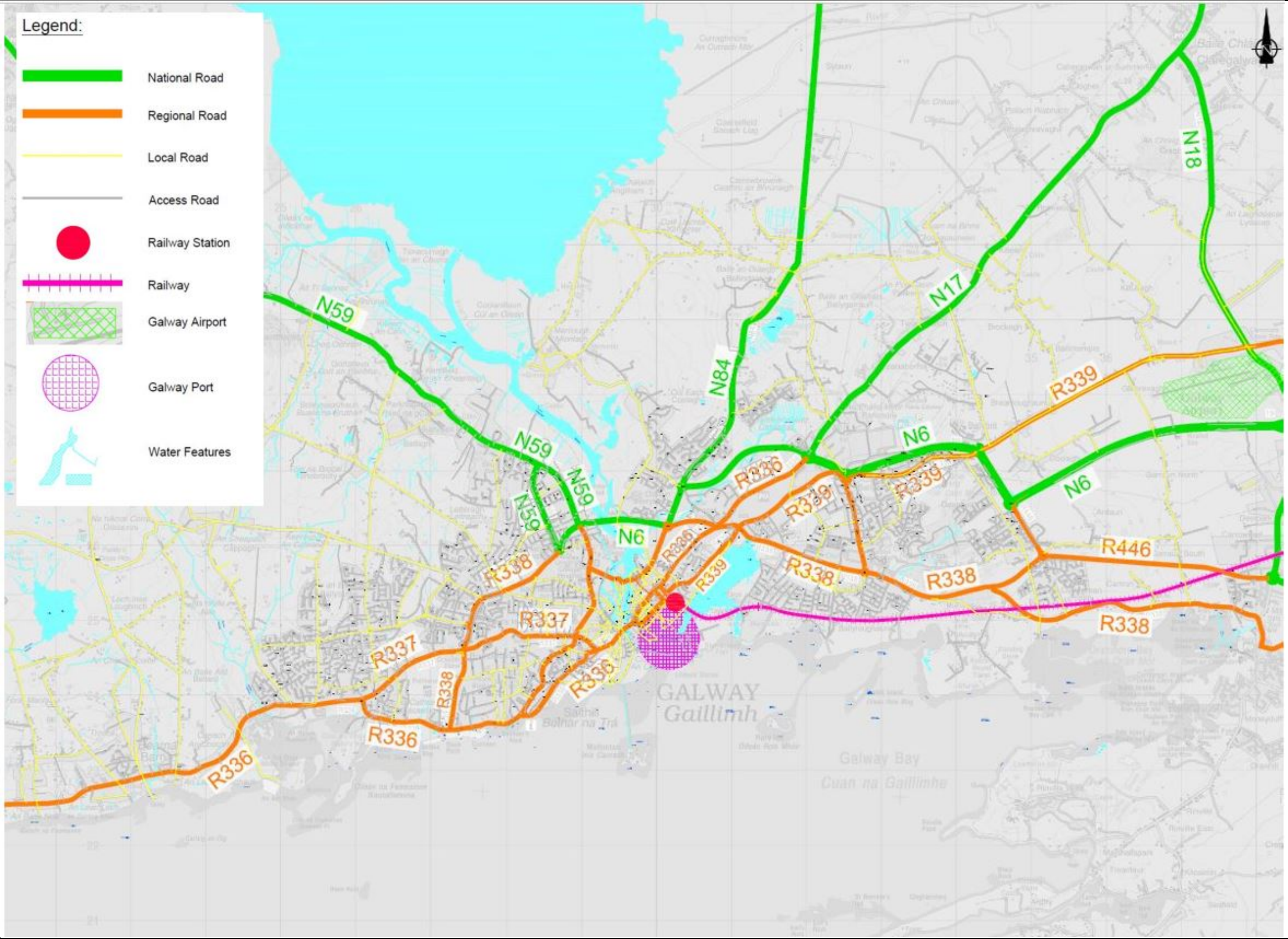
An understanding of the existing road network is critical in the development of a transport solution.

The existing road network which is described in **Chapter 6, Traffic Assessment and Route Cross-Section,** consists of the existing N6, a National Primary route which connects the N6 on the east side of Galway at Coolagh to the N59 Moycullen Road and the R338 on the north-west side of Galway at Newcastle. The existing N6 passes though the environs of Galway City, namely Briarhill, Ballybrit, Ballybane and Terryland on the east side of River Corrib and Newcastle on the west of the river. The existing N6 terminates at the R338 at the at-grade roundabout junction, Browne Roundabout, with the N59. The R338 continues in a westerly direction to the Coast Road, the R336. Whilst the existing N6 bypasses Galway City Centre, a large portion of the traffic on the N6/R338 is not fully bypassing Galway City environs, rather it is using the existing N6 and the R338 to move in an east/west direction across the city, refer **Plate 3.1** below.

The existing N6 is a four lane carriageway between the M6/N6 and the N59 Moycullen Road, with a varying median width, and a number of at-grade junctions comprising of at-grade roundabouts and signalised junctions. The R338 varies in cross section consisting of four lanes, two of which are bus lanes as far at the Deane Roundabout and two lanes for traffic from there to the R336 Coast Road. There are various forms of at-grade junctions including roundabouts, signals and priority junctions on the R338 from its junction with the N59 Moycullen Road as far as the R336.

The existing road network is at capacity and insufficient to cater for the current travel demand in Galway City, its environs and the Western Region. Therefore, the transport solution must address the existing road network capacity. The key performance indicators used to assess the capacity of the existing road network include an analysis of the existing travel patterns to understand the requirements of the ultimate transport solution, analysis of journey time and assessment of junction capacity.

Plate 3.1: Existing Road Infrastructure



3.2.2 Existing Travel Patterns

An understanding of existing travel patterns is critical in the development of a transport solution. Initial feasibility studies identified the zones of employment, education, retail and residential, i.e. these are known as zones of traffic generators and attractors. These zones are shown on **Plate 3.2**. This graphic shows the residential areas interwoven with the key attractors with the resultant travel desire lines also displayed, and demonstrates how the River Corrib divides this city.

Early studies identified that Galway has a transport problem, and moreover it has is a multifaceted transport problem that needs more extensive analysis to fully understand all the issues. For this reason, the traffic analysis was carried out using the detailed multi-modal traffic model, i.e. the Western Regional Traffic Model, which was developed by the National Transport Authority.

Analysis of the Western Regional Traffic Model provided a very clear and reliable picture of travel patterns in and around Galway City and the wider region, including data on multiple modes of travel, namely (i) public transport, (ii) private vehicles, (iii) cycling and (iv) pedestrians.

Analysis of the travel patterns informed the understanding of travel demand in Galway City and its environs, which in turn has guided the selection of an optimum transport solution which matches demand. Capacity for the current demand and more critically demand into the future was of critical importance in developing this transport solution – there are not multiple opportunities or indeed multiple alternatives, therefore, it is imperative that this solution is the correct solution for the future.

Plate 3.2: Traffic Generators and Attractors

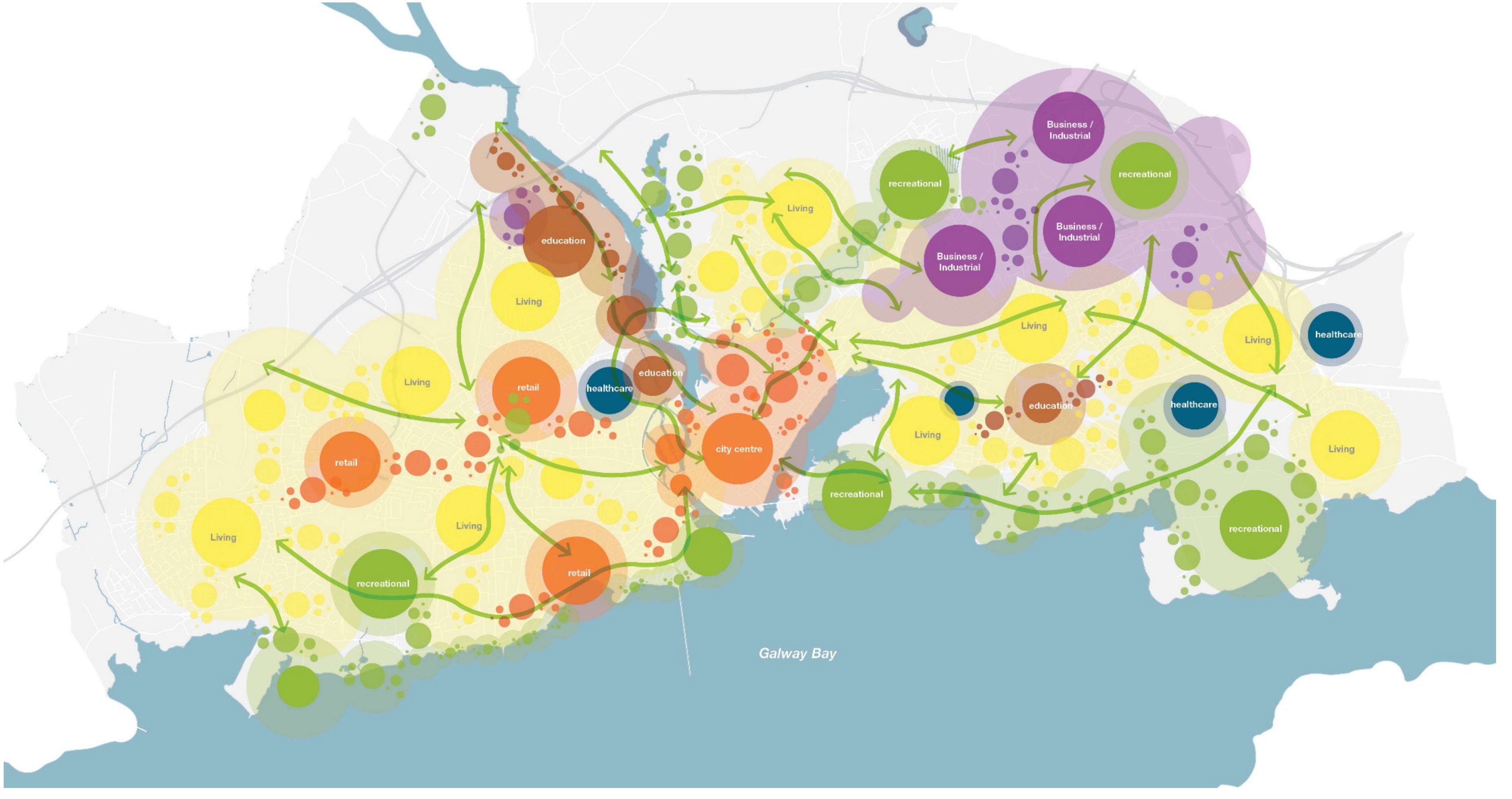
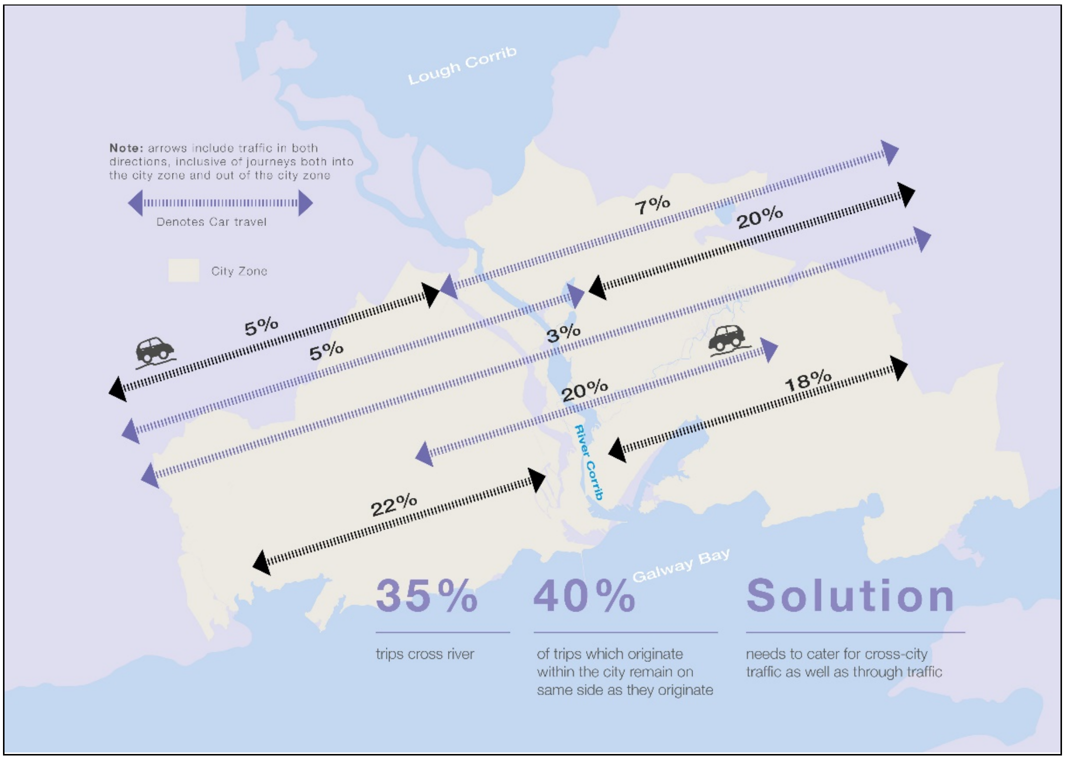


Plate 3.3 below is a schematic diagram to illustrate the travel patterns for private car trips to, from or through Galway City in the 2012 Base Year morning peak hour (extracted from the traffic model, ref **Chapter 6, Traffic Assessment and Route Cross-Section**). Red arrows show movements that cross the River Corrib and green arrows show movements that do not cross the River Corrib.

As shown in **Plate 3.3**:

- 35% of all journeys into and out of the city zone and around Galway City (city zone) cross the River Corrib, of which approximately 9% are bypass traffic (i.e. 3% of 35%)
- 40% of all journeys originate and terminate within the city zone on the same side of the city as where they started i.e. do not cross the river
- Approximately 20% of all journeys are within the city zone and cross the river

Plate 3.3: Travel Patterns 2012 Base Year Morning Peak Hour



This analysis shows that the transport solution must be multi-modal catering for the following various demands:

- High proportion of short journeys within the city zone can be accomplished via public transport, cycling or walking i.e. approximately 40% of journeys commencing in the city which remain on the same side of the city as they started are short trips, both in time and distance
- A further 20% of journeys are from one side of the city to the other are also short journeys, making them clear targets for a shift to public transport

- Improved connectivity to the national road network for those on the western side of the River Corrib which is only possible at present by using one of the city centre bridge crossings

Whilst the overall transport solution clearly must serve a multi-modal demand, this analysis of demand also shows that the transport solution must separate the conflicting demands and serve them via differing appropriate transport modes so that this significant infrastructural investment is protected and secured for the future.

The lack of such a multi-modal transport network has wider impacts on all transport modes including the following:

- Impacts on the public transport network which results in prolonged journey times and delays on the current bus network
- Reduces opportunities for safe and comfortable cycling
- Peak hour traffic delays
- Thousands of vehicles per day travel unnecessarily through the city centre which brings with it associated and unmitigated impacts on businesses, public facilities, homes and non-motorised road users

3.2.3 Journey Time Reliability

Analysis of travel surveys, journey times and delays on the existing network was carried out to establish a set of measurable key performance indicators (KPI) to define the existing problems and with which to compare future potential solutions.

An analysis of observed journey times on three key routes around Galway and its environs as shown on **Plate 3.4** below was carried out to show the variance in journey times between the peak and off-peak periods in the Base Year. The difference between the peak and off-peak journey times is a measure of the level of congestion during the peak, and increasing congestion results in worsening journey time reliability.

Observed travel times in 2012 Base Year on each of the existing N6, the N84 Headford Road and N83[1] Tuam Road, in the inbound direction in the morning peak period versus the off-peak period are tabulated in **Table 3.1** below.

This assessment of journey time shows that the travel times on these three key routes in the morning peak hour are on average more than double the off-peak travel times.

[1] Formally known as the N17 Tuam Road.

Plate 3.4: Journey Time Reliability Routes

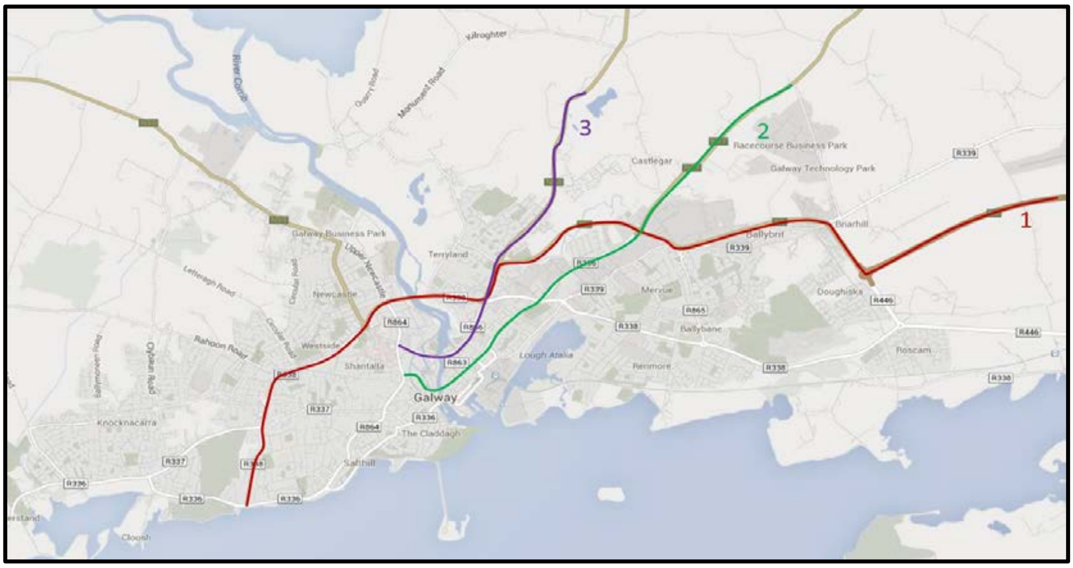


Table 3.1: Journey Time Reliability

		2012 Observed Journey Times (minutes)			
		Off-peak average hour	**Morning peak hour**	**Difference**	**% Difference**
Inbound	Route 1 IN	14	28	14	100%
	Route 2 IN	14	25	11	79%
	Route 3 IN	8	19	11	138%
	Average	12	24	12	105%

Journey time unreliability is a significant detractor to incoming businesses seeking to locate in the area, to tourism due to difficulties of scheduling timetables and also to indigenous industries attempting to get goods out to national markets.

Bus connections in City Centre rely on 15/20/30 minute schedules. These schedules are not achievable due to congestion within the city centre. Connections are then missed with the resultant being that cross city bus trips take over an hour.

Therefore, the transport solution must address journey time unreliability as again this has wider impacts including the following:

- Unreliable transport links to access markets within the city
- Unreliable transport connections from Galway onwards to Connemara
- Lack of accessibility to the Western Region as a whole
- Peak hour traffic delays
- Prolonged journey times and delays on the current bus network
- Difficulty of attracting businesses to Galway City and its environs

3.2.4 Junction Capacity Assessment

Congestion arises due to capacity failures of the existing junctions. This congestion is crippling and stifling city living as well as cutting off access from the wider region to employment and services in the city. These existing junctions are expected to perform the dual role of accommodating traffic wishing to circulate around the city as well as traffic on the radial routes trying to access the city.

An assessment of the volume/capacity (V/C) ratio was undertaken at signalised junctions and roundabouts, plus other key junctions where main roads intersect as shown on **Plate 3.5**. Max turn V/Cs show the maximum volume-to-capacity ratio for the turns at each junction. This indicator is useful for highlighting the problem junctions, compared to the average V/C or average delay, which can be dominated by the high-volume low-delay movements. The volume to capacity ratios are then related to level of delay and congestion at the junctions.

Plate 3.5: Volume/Capacity Ratios at Junctions (2012)

Plate 3.5 shows the number of junctions with a max turn V/C within standard ranges of 0.85-1.00, 1.00-1.15 and >1.15. Junctions with a V/C ratio greater than 1 have exceeded their capacity. Ideally junctions should operate at a V/C ratio of < 0.85, which would allow 15% spare capacity in the junction to cope with an unexpected event or natural growth.

This analysis demonstrates that the existing network is restricted by junction capacity. The junctions on the critical corridors accessing the city, namely the junctions of the N84, N83 and N59 Junctions with the existing N6, have all currently exceeded their capacity at peak hour as shown on **Plate 3.5** above. These junctions are operating at greater than 100% of their capacity, which in turn leads to the significant delays at these junctions. As these junctions are the main arteries into the city and the main junctions on the circumferential route around the city, this is a significant issue for the Gateway of Galway.

In addition, approximately 40% of all junctions on the key access routes across Galway City and its environs are operating above 85% capacity. This demonstrates that the network is finely balanced with minimal spare capacity to allow for any unforeseen event or natural growth. This is significant as grid-lock on a city wide scale is evident in the event of an unforeseen occurrence such as an accident, significant weather event, temporary traffic management associated with regular maintenance works on the existing road network, seasonal events and particular match day events.

Therefore, the transport solution must address junction capacity as again this has wider impacts including the following:

- Congestion throughout the city road network
- Journey time unreliability and journey time variability throughout the day
- Peak hour traffic delays
- Limits access to markets within the city and onwards to Connemara
- Delays to the National and Regional road network
- Accessibility issues for the entire Western Region

3.2.5 Long Term Impacts

The potential long term impacts on the social and economic fabric of Galway will be significant if transport issues are not addressed. Macro-economic impacts which may arise could include any or all of the following:

- Disincentive for Foreign Direct Investment (FDI) to invest in Galway City due to congestion costs in terms of both goods and labour
- Decline in the quality of the urban environment due to increased congestion and pollution may lead to reduced attractiveness of Galway City for labour force location
- Decline in the quality of the urban environment could exacerbate the already existing trend to live outside the city limits and commute to Galway for work, increasing congestion and reducing the potential for any investment in public transport or alternative means of travel, to make an impact
- May lead to further relocating of other activities away from the city core e.g. retail, business, employment, leisure, reducing the strength of Galway as a Gateway City
- Impact on the economic development of the wider western region as access is compromised (labour, goods, tourism)
- Suppressed travel movements either side of the River Corrib, resulting in isolation of areas of the city and county
- Overall, can lead to the decline of Galway City to act as a Gateway on the western corridor, and act as a regional counter balance to the east

- Create two separate city areas either side of River Corrib, with the city and county to the west declining

Social impacts resulting from the above could include:

- Create a challenging environment in accessibility terms for some sectors of society, particularly those most dependent on non-private car travel, as investment in public transport will be harder to justify over a more dispersed city fabric
- Potential reduction in range of employment options available which could impact the profile of residents in the city and corresponding impacts on communities
- Reduction in quality of life indicators

Given the potential long term impacts above, there is a strong need to address the transportation issues facing the city and surrounding areas at present, and to underpin future growth by establishing a long-term strategy for transport to, within and around the city.

3.2.6 Significant constraints for developing new transport infrastructure

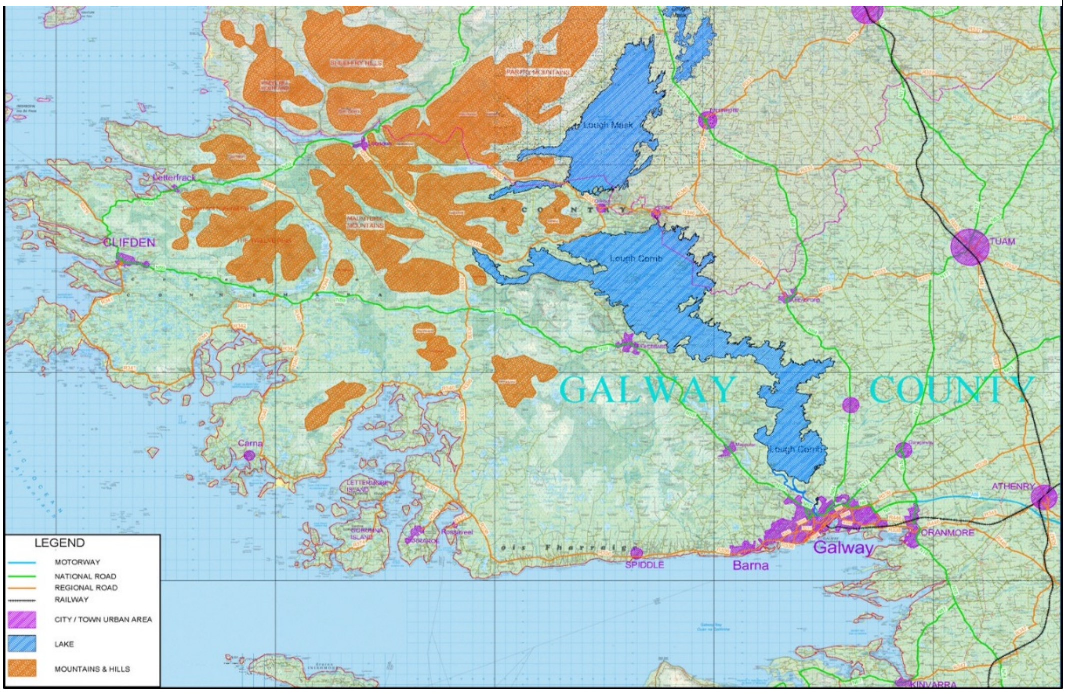
Galway is a city of contrasts in terms of its physical development and transport requirements. While Galway has a compact walkable core, outside of the city centre, the suburbs have developed as a succession of low density residential areas interspersed with employment areas, leading to a predominance of private car usage as a means of travel. There are significant constraints for developing new transport infrastructure in Galway which arise principally due to:

1. the physical form of the city
2. the limited space available
3. the built environment and residential areas on both sides of the River Corrib
4. the presence of designated sites of international significance

Galway City is physically constrained as it is divided in an east west direction by the River Corrib and a sea inlet known as Lough Atalia, bounded along the entire southern boundary by Galway Bay and the northern boundary by Lough Corrib, all of which are natural barriers to free movement and development. There are currently four bridges crossing the river, which cumulatively carry approximately 80,000 vehicles per day. Three of the four bridges are within the city centre, thus drawing traffic into the city for the sole purpose of crossing the river.

Galway County and Connemara as far west as Clifden and onto Letterfrack are equally dependent on this narrow funnel for access, as access to this area is restricted by the extents of Lough Corrib heading north, the Twelve Bens mountains, the Maamturk mountains and the many smaller lakes. **Plate 3.6** below highlights that access to this area is via the bridges across the River Corrib in Galway City due to the physical natural constraints.

Plate 3.6: Existing Natural Constraints



In summary:

- The low density of the suburbs of Galway has led to reliance on private car usage as a means of travel and makes it difficult to develop an economically efficient public transport solution
- Galway City is divided by the River Corrib as it flows between Lough Corrib and Galway Bay with significant trip attractors, employment centres, education centres and residential areas located on both sides of the river
- Lough Corrib forms a natural division between the east and west of County Galway and the distance between Lough Corrib and Galway Bay is only 4.5km[2] within which lies Galway City, very much at the heart of County Galway
- The city is located in the middle of areas which are rich in natural heritage with a wealth of natural habitats. This has resulted in significant areas around Galway City being designated of international importance

3.3 Project Objectives

The overall ambition of the proposed road development is to achieve a number of specific objectives under a number of multi criteria categories. These multi criteria are outlined by the Department of Transport in *Guidelines on a Common Appraisal Framework for Transport Projects and Programme March 2016*. By considering the objectives under these headings, it is the intention to provide a project which is attractive to all, delivers the road component of the overall transport solution for

[2] Distance measured from south shore of Lough Corrib to Spanish Arch at Galway Docks

Galway and its environs, provides benefit to the local and the larger regional population of Galway and the western region and is cognisant of the sensitive environment into which it is interwoven. The multi criteria headings are as follows:

- Economy
- Safety
- Environment
- Physical Activity
- Accessibility & Social Inclusion
- Integration

Each of these objectives are linked to the European, national, regional and local polices set out in **Chapter 2, Planning and Policy Context**. Every endeavour has been made to ensure these objectives were met as much as possible in the development of the proposed road development. The specific objectives under each of the headings are detailed below.

The ***'Economic'*** objectives of the proposed road development include:

- Encourage local, regional, national and international development
- Reduce journey times
- Increase journey time certainty
- Support the economic performance of the Gateway of Galway as the only large employer in the region
- Provide benefits to the transport infrastructure
- Improve connectivity to the Gateway of Galway
- Improve linkages between the west and east sides of the city and county
- Deliver a cost effective project

The ***'Safety'*** Objectives of the proposed road development include:

- Segregation of the interface of strategic traffic from local traffic
- Reduction in road traffic collisions
- Provision of safer urban streets

The ***'Environmental'*** Objectives of the proposed road development include:

- Minimise impacts on designated Natura 2000 sites
- Avoid impacts to National Monuments
- Minimise impacts to the architectural, cultural or linguistic heritage of the area
- Take due cognisance of the importance of the existing landscape
- Seek to preserve existing well established communities
- Reduce noise and air impacts on sensitive receptors
- Deliver a sustainable transport solution

The ***'Physical Activity'*** Objectives of the proposed road development include:

- Improve accessibility to Galway City
- Improve opportunities for walking in the core city centre area by creating more walkable environments
- Reallocation of road space for the provision of additional cycling facilities on less congested urban streets

The ***'Accessibility and Social Inclusion'*** Objectives of the proposed road development include:

- Improve accessibility to Galway City
- Interconnection of the Galway City and its environs road network to the national motorway network
- Improve accessibility of Galway urban area to its main markets
- Improve accessibility of the Gaeltacht areas to the remainder of the county and country
- Reduce disadvantage of the Gaeltacht areas
- Implement sustainable transport policies for shorter commutes
- Improve urban environment of Galway City centre
- Support the improvement of the public transport hub linking Galway to other Gateways
- Support the current development strategy and settlement strategy

The ***'Integration'*** Objectives of the proposed road development include:

- Support the development of critical-mass of regional population centres
- Integration of Galway City and its environs (including western parts of Galway County) into the national economic development agenda
- Support balanced social and economic development at a national level
- Support balanced social and economic development at a city-region level
- Understanding of the development, land-use and transportation pressures in the Galway urban area and their impact on the delivery of a successful city region at Galway
- To deliver on Galway's potential as Ireland's fourth largest city and an important residential, educational, employment and service centre for a wide regional hinterland, contributing to the national urban hierarchy
- Recognition of the role of Galway City as a gateway to the west and Connemara, and the consequent socio-economic benefits of enhanced connectivity of Galway City to national markets, enhanced tourism accessibility, and the national transport system
- Improvement of the TEN-T network to ensure connectivity of the west of Ireland to the single European market.

These project objectives were used to guide the development of a transport solution for Galway City and its environs. A subsequent appraisal of these objectives against the need for the proposed road development and how these objectives were met is presented in **Section 3.7** below.

3.4 Development of a Transport Solution for Galway

3.4.1 Overview

As outlined previously in **Chapter 1, Introduction**, the initial studies for a transport solution were undertaken as part of the N6 Galway City Transport Project (GCTP). In parallel to the GCTP, Galway City Council and Galway County Council, in partnership with the NTA developed an overall transport strategy for Galway City and its environs, and is referred to as the Galway Transport Strategy (GTS). The GTS is the transport solution for Galway.

The GTS took into account the existing transport issues as described in **Section 3.2** above. The traffic issues in Galway City and its environs were carefully considered and analysed with the aim of finding a transport solution to create a safer, smarter and sustainable transport system for Galway City and its environs taking into account travel demands, existing infrastructure and environmental constraints.

The GTS included an evaluation of transport options for all modes, and affirmed the strategic need for an orbital route around the city and a new crossing of the River Corrib, in order to implement the level of service required for each mode of transport, including walking, cycling, public transport and private vehicle. The provision of an additional crossing of the River Corrib would facilitate the reduction of congestion on city centre roads, and allow the reallocation of road space in the city network to non-motorised modes of transport, thereby facilitating the effective implementation of all the elements contained in the GTS, namely the improvement of public transport, cycling and walking measures. A new road link to the north of the city is proposed as part of the GTS to deliver the necessary capacity and support the delivery of sustainable transport measures, particularly within the city centre.

The initial studies carried out as part of the N6 GCTP confirmed that a new River Corrib bridge crossing is possible and identified a preferred location for this crossing.

The N6 Galway City Ring Road (GCRR) will deliver the additional crossing of the River Corrib and the new link road as proposed by the GTS. Therefore, the proposed road development forms an essential part of the GTS, it delivers the road component of the overall transport solution for Galway City and its environs, provides benefit to the local and the larger regional population of Galway and the western region and is cognisant of the sensitive environment into which it is interwoven.

The need for the proposed road development, the N6 Galway City Ring Road, is justified as it will deliver the following:

- By tackling the city's congestion issues, it will provide a better quality of life for the city's inhabitants and provide a much safer environment in which to live
- By reducing the number of cars on the roads within the city centre and improving streetscapes, workers and students are facilitated to commute using

multi-modal transport means. This includes travelling on foot, by bicycle and on the public transport system

- Provides connectivity to the national roads via junctions to maximise the transfer of cross-city movements to the new road infrastructure, thus releasing and freeing the existing city centre zone from congestion caused by traffic trying to access a city centre bridge to cross the River Corrib
- Attracts traffic from the city centre zone thus facilitating reallocation of road space to public transport leading to improved journey time reliability for public transport
- Caters for the strong demand between zones on either side of the city
- Provides additional river crossing with connectivity back to the city either side of the bridge crossing
- Facilitates improved city centre environment for all due to reduced congestion, thus encouraging walking and cycling as safe transport modes

The need for the proposed road development in terms of delivering the road component of the transport solution for Galway, in the context of how such a development can address the transport issues raised in **Section 3.2** above is discussed below.

3.4.2 Existing Road Network Issues

The existing road network is at capacity and insufficient to cater with the current travel demand in Galway City, its environs and the Western Region. The proposed road development will replace the role of the existing N6/R338 road network. By serving strategic traffic currently trying to cross the city via the existing N6 as well as the strategic traffic that is currently trying to rat-run through the city using the existing city street network due to the congestion levels on the national road network, the proposed road development will free up road space in the city centre that can be used by other modes of transport. The city at its heart serves a strategic function as the economic engine for the Western region and must be free of congestion to enable it to do so. This is supported in terms of policy from national to local level which is outlined in **Chapter 2, Planning and Policy Context**.

3.4.3 Existing Travel Patterns

The need for the proposed road development, the N6 Galway City Ring Road, is justified as it serves the existing travel demands as follows:

- Caters for the strong demand between zones on either side of the city
- Facilitates crossing the River Corrib without negotiating the city centre
- Provides this additional river crossing with connectivity back to the city either side of the bridge crossing
- Attracts traffic out from the city centre zone thus facilitating reallocation of road space to public transport leading to improve journey time reliability for public transport

- Facilitates improved city centre environment for all due to reduced congestion, thus encouraging walking and cycling as safe transport modes
- Improves connectivity to the Western Region i.e. the county areas and hinterland beyond the city zone
- Provides essential city street links to better distribute traffic
- Provides connectivity to the national roads via junctions to maximise the transfer of cross-city movements to the new road infrastructure, thus releasing and freeing the existing city centre zone from congestion caused by traffic trying to access a city centre bridge to cross the River Corrib
- Provides a high quality road with limited access

3.4.4 Journey Time Reliability

The proposed road development seeks to address this issue through relief of the traffic congestion by removal of traffic both through modal shift, provision of additional road space and separation of bypass traffic.

The traffic modelling of the proposed road development, which is discussed in **Chapter 6**, **Traffic Assessment and Route Cross-Section**, demonstrates how the proposed road development achieves these goals which form the basis of the need for the proposed road development. The proposed road development provides connectivity to the national roads via junctions to maximise the transfer of cross-city movements to the new road infrastructure, thus releasing and freeing the existing city centre zone from congestion caused by traffic trying to access a city centre bridge to cross the River Corrib. This reduction in congestion will lead to lower collision rates and improve conditions for vulnerable road users.

3.4.5 Junction Capacity Assessment

The proposed road development is required to resolve this constant lingering problem of junctions with no spare capacity on the existing N6 route and existing network which frequently results in grid-lock in the city. This links to the congestion relief discussed in **Section 3.2.1.3**, all of which promotes the need for the proposed road development.

3.5 Strategic Fit and Priority within the National Road Programme

Transport Infrastructure Irelands (TII) primary function under the Roads Act 1993, is to secure the provision of a safe and efficient network of national roads. For this purpose, it has overall responsibility for the planning and delivery of new national roads, road network management and maintenance on national roads.

The objective of the TII capital expenditure programme is to improve the safety and efficiency of the national road network to make it fit for freight, business and social travel. Developing, maintaining and operating the national road network in a safe, cost effective and sustainable manner generates an improved quality of life and national economic competitiveness.

The three strategic priorities for TII are summarised as follows:

"Priority 1 – Asset Management, Network Rehabilitation and Network Operations;

Priority 2 – National Secondary Roads Improvements, Bottleneck Improvement Projects, Safety Projects and Traffic Management Projects; and

Priority 3 – Network Improvement Projects."

The proposed road development links four national routes around Galway City, namely N59, N84, N83 and N6. It also links a number of regional routes including the R336, which accesses south Connemara, refer **Plate 3.1**. The proposed road development is the mechanism to convey traffic east to west from the north and south and effectively encompasses all three of TII priorities whereby the existing primary road network is rehabilitated and improved, providing safety benefits and congestion/bottleneck improvements.

Investment in the proposed road development adds value to the overall strategic national roads network for the country, see also **Chapter 2, Planning and Policy Context**.

3.6 TEN-T Comprehensive Road Network

As discussed in **Chapter 2, Planning and Policy Context**, the proposed road development forms part of the TEN-T comprehensive road network and as such has a strategic function. This is discussed under various headings which are fundamental to understanding the purpose of TEN-T and to understanding why the proposed road development is of strategic importance.

TEN-T Classification

- The proposed road development was developed to be part of Ireland's comprehensive network in accordance with the European Union's (EU) TEN-T[3] Transport Policy
- The EU's TEN-T Transport Policy aims to create connectivity between regions, remove bottlenecks that hamper the smooth functioning of the EU's internal market and to promote a sustainable, multi-modal network for passengers
- The proposed road development has been developed as a high-quality road as part of the TEN-T comprehensive network to deliver the objectives of TEN-T both on a strategic national and European level, as well as on a regional level to the Western Region. The proposed road development is intended to support the economic and social development of the Western Region, by ensuring the connectivity and accessibility of this region to the single European market

Connectivity, Accessibility and Social Inclusion

- One of the principal aims of TEN-T is to improve cohesion throughout the EU by ensuring the connectivity and accessibility of all regions, including the EU's outermost and remote regions. The proposed road development will improve

[3] http://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/map/maps.html

linkages between the west and east sides of the country, as well as improving the connections between the Western Region and the wider internal market within the EU

- It will improve the accessibility of Galway City to its main markets, by facilitating the crossing of the River Corrib without the need to go through the city centre. The proposed road development will protect the interconnection of Galway City and its environs road system to the national motorway network. This will increase the connectivity of key strategic services within Galway, such as NUIG and Galway University Hospitals, to the national motorway network
- The proposed road development will also improve the accessibility of Gaeltacht areas to the remainder of the county and country, thereby reducing the economic and social disadvantages of the Gaeltacht areas, as it will provide the capacity required for national and international traffic serving the Western region whilst also connecting the county to the national network
- Access to this strategic route is limited to the junctions provided along the route, which will protect the asset in the future and the proposed road development has been designed to ensure that it is not misused as a ‘hop on hop off’ network for local traffic. Junctions have been restricted to the western tie-in with the R336 Coast Road, Bearna Moycullen Road, Cappagh Road, Ballymoneen Road and the national roads, N59, N84, N83 and the existing N6. This level of provision is deemed necessary to serve the strategic travel demand, as the traffic accessing Galway City is of a strategic nature, whilst also providing connections for users from the Western Region to the national road network

Removing Infrastructural Bottlenecks

- The TEN-T aims to increase efficiency throughout the transport network by removing bottlenecks and congestion. Currently, Galway City experiences transport problems across the city, particularly during peak hours, which is impacting on the economic capability of the city. The road and street network of Galway City is ill-suited to the high traffic flows currently prevalent and contributing to increased congestion and delay, affecting quality of life and impacting on the functionality of the city
- The effects of this congestion and bottlenecks extend to the wider county and region, due to the large number of people commuting daily for work or education to the city from the surrounding towns, villages and rural areas. The congestion and infrastructural bottlenecks impact the connectivity of the Western Region to the rest of the country and the internal markets of the EU
- The proposed road development is a key element of the GTS as it aims to resolve the congestion which is restricting the Western Region currently and is experienced by all travellers using various transport modes

Sustainable Transport Choices for Passengers

- TEN-T aims to promote sustainable travel by creating a multi`-modal transport network, which meets the mobility and transport needs of its users. The N6 GCRR will reduce congestion and car dependency by attracting traffic from the city centre zone, which will facilitate a reallocation of road space. This will improve capacity and reliability of public transport and will facilitate greater opportunities for cycling and walking within the city centre core area

- By providing opportunities for a multi-modal transport system, the N6 GCRR promotes the reduction of greenhouse gas emissions as it facilitates the advancement of a low-carbon and more energy efficient transport system, whilst also providing accessibility and connections to the city. This also reduces the level of air pollution within the city centre. The GTS aims to relieve traffic congestion in the urban centre of Galway which in turn will facilitate a modal shift to public transport, cycling and walking, all of which promotes the reduction of greenhouse gas emissions as it facilitates the advancement of a low-carbon and more energy efficient transport system

Therefore, it can be concluded that the proposed road development serves a dual purpose for the following reasons:

- it provides for the strategic need of the TEN-T comprehensive road network and connects Galway City and the Western Region to the national road network
- it provides an additional crossing of the River Corrib, thus facilitating the reduction of congestion on city centre roads, and allowing the reallocation of road space in the city network to non-motorised modes of transport, thereby facilitating the effective implementation of all the elements contained in the GTS, namely the improvement of public transport, cycling and walking measures

There is no tension between these two functions, in so far as the whole transport strategy has been developed so that traffic is segregated and directed to the most appropriate mode, which allows the road component to serve the function for which it is designed. By serving strategic traffic currently trying to cross the city via the existing N6 as well as the strategic traffic that is currently trying to rat-run through the city using the existing city street network due to the congestion levels on the national road network, the proposed road development will free up road space in the city centre that can be used by other modes of transport. The city at its heart serves a strategic function as the economic engine for the Western Region and must be free of congestion to enable it to do so. It is critical to understand the strategic function of the proposed road development and to understand why it is classified as part of the TEN-T comprehensive road network as discussed above.

3.7 Appraisal Framework for Transport Projects

In accordance with the Department of Transport’s “Guidelines on a Common Appraisal Framework for Transport Projects and Programmes” (updated March 2016), the need for the proposed road development is described below against the six criteria of Economy, Safety, Physical Activity, Environment, Accessibility and Social Inclusion and Integration. The importance of providing a sustainable development is also considered.

3.7.1 Economy

Recent national developments mean that, more than ever, each region of the country has a crucial role to play in returning Ireland's economy to enterprise driven growth. The delivery of dynamic, competitive regions that provide quality and sustainable employment opportunities will involve not only the enterprise development agencies, but also a wide range of stakeholders including local authorities, higher education institutes and the business community at local, regional and national levels.

The proposed road development will provide an economic benefit to Galway City and environs. Whilst there is a profitable business opportunity during the construction phase for contractors and suppliers, the true economic benefit will be realised once the proposed road development is completed. Accessibility to businesses and community facilities in Galway City and its environs and the Business Parks in Parkmore and Ballybrit will be better facilitated by the proposed road development and the resulting reduction in congestion. It will also bring with it benefits to business and public facilities in Galway City centre by reducing noise and air pollution. This all translates into economic prosperity for the Western Region, with Galway City as a thriving city at the core, which in turn will play a part in reviving the Irish economy.

The proposed road development will provide a high quality roadway asset designed in accordance with current TII Design Standards and Guidance.

An efficient integrated transport infrastructure is necessary to reduce levels of congestion and allow economic growth. The proposed road development facilitates this improvement by providing relief to the national, regional and local road network, whilst also improving accessibility of the public transport network and allowing advancement of sustainable transport planning at a local level.

3.7.2 Safety

The existing traffic volumes and HGVs on the existing road network leads to traffic congestion on a consistent basis. As outlined in **Chapter 6, Traffic Assessment and Route Cross-Section**, the proposed road development provides connectivity to the national roads via junctions to maximise the transfer of cross-city movements to the new road infrastructure, thus releasing and freeing the existing city centre zone from congestion caused by traffic trying to access a city centre bridge to cross the River Corrib. This reduction in congestion will lead to lower collision rates and improve conditions for vulnerable road users.

Providing improved road infrastructure generates significant safety benefits to the network at two levels, firstly via the transfer of high volumes of traffic to the safer roads and secondly via a reduction in distances travelled on less safe existing roads. Modern technology and information systems which form part of new road infrastructure also gives greater security to road users. Opportunities for further safety benefits present through the provision for vulnerable road users through reallocation of road space on the existing network. Safety and security on our road network is of national interest and a key part of government policy over the past decades.

3.7.3 Physical Activity

The latest Common Appraisal Framework (CAF) update has included an additional criterion for appraisal namely Physical Activity. The existing N6/R336 is a deterrent to physical activity due to lack of attractive provision for vulnerable road users – cycling and walking adjacent to heavily congested commuting routes and requirement to negotiated complex multi-phase traffic signals at crossings. Whilst the N6 GCRR does not necessarily provide for increased levels of activity in itself, the objective set at the outset is to create opportunities for walking in the core city centre area and to reallocate road space for the provision of additional cycling facilities. The N6 GCRR meets this project objective as it is part of an overall strategy whereby road space is reallocated to cyclists and pedestrians once traffic is removed from the city centre to the proposed ring road.

3.7.4 Environment

The proposed road development is going to have negative impacts on the receiving environment including, unfortunately, a significant level of property demolitions that are unavoidable. From the outset of the design of the proposed road development every effort was made to avoid property demolitions where possible. However, there are still property impacts and it is proposed that 69 non-agricultural properties will be acquired or demolished (refer to **Chapter 5, Description of the Proposed Road Development** and **Chapter 15, Material Assets Non-Agriculture** for further details).

Whilst this is a significant number of property impacts with the associated impacts on families in these properties, the overall context of the impacts is assessed against the potential benefits that can be accrued from the proposed road development. The proposed road development provides the very significant and very much needed benefits to the EU transport network, the Western Region and County Galway as well as the built-up environment of Galway City and environs and the location required for the road infrastructure.

The routing of thousands of vehicles per day through the city centre brings with it associated and unmitigated impacts on businesses, public facilities, homes and non-motorised road users. These impacts include noise and air pollution. The stop/start nature of urban driving and platooning of vehicles behind slow moving vehicles adds to the levels of pollution experienced by locals and visitors. The proposed road development provides an additional crossing of the River Corrib, thus facilitating the reduction of congestion on city centre roads, and allows the reallocation of road space in the city network to non-motorised modes of transport, thereby reducing the level of pollution within the city centre.

Additional impacts on the receiving environment at present include severance effects of traffic congestion in urban areas and traffic speeds in rural areas as local roads are used to avoid the congested national road network. This severance will be reduced by the transfer of traffic to the proposed road development.

As outlined in **Chapter 2, Planning and Policy**, the Climate Action and Low Carbon Development Act 2015 provides for the establishment of a national framework with the aim of achieving a low-carbon, climate-resilient, and environmentally sustainable economy by 2050. There is a national need to lower Ireland's level of greenhouse gas emissions and the government have made a commitment to reduce Ireland's carbon footprint.

The proposed road development will facilitate the advancement of a low-carbon and more energy efficient transport system, as well as developing more efficient urban and intermodal transport solutions by removing traffic from the city centre and freeing up space for cycling and walking facilities as well as improved bus transport. This will also bring an additional positive impact on air quality where traffic is diverted away from the receptors along the existing road network within the city centre as a result of the proposed road development.

From an environmental perspective, European, National and Local legislation requires that the environmental impacts associated with major roads projects are identified and measures taken to avoid, minimise or mitigate these impacts. The proposed road development will be constructed to the increasingly high standard of environmental mitigation practice. Refer to individual sections of this EIAR for an in-depth discussion of potential environmental impacts and details of how these will be avoided, minimised and mitigated.

The need for the proposed road development from an environmental sustainability perspective is to deliver an integrated, sustainable transport solution that aligns transport investment with settlement patterns, travel movements and also supports a sustainable use of land. The proposed road development as part of the GTS, satisfies this need as it offers opportunities that will reduce congestion and car dependency through facilitating a reallocation of road space to improve capacity and reliability of public transport and to facilitate cycling and walking within the city centre core area, with a resultant 16% increase in public transport trips in 2039 when compared to the scenario of not progressing the scheme, all of which promotes the reduction of greenhouse gas emissions, whilst also providing accessibility and connections to the city.

3.7.5 Accessibility and Social Inclusion

As a Gateway to the Connemara and the Western Region, connectivity and accessibility to and through Galway City is essential in aiding the region to revitalise, improve and develop into the future. Accessibility and connectivity for areas within the county is of significant public interest and a key driver for this proposed road development; however, given that any proposed infrastructure seeking to link either side of the county will traverse areas of the city, then accessibility to and from and within the city is inextricably linked to this proposed road development.

Providing well developed transport links via roads, rail and air to the Western Region, enables enterprises and the local economy of the west to grow and develop as a viable alternative to the east coast corridor which is of significant public interest at a national level.

The Galway Transport Strategy (GTS), which is an overall transport strategy for Galway City and its environs for the next twenty years, consists of a number of proposed measures combined under an overall vision "*to create a connected city* *region driven by smarter mobility*”. The proposed road development is among the major components proposed under the GTS. Other components include provision of a new cross-city link; an enhanced local public transport network and regional public transport service; provision of greenways as well as a range of other additional non-greenway cycling, pedestrian and public realm improvements; and complementary measures. The proposed road development is needed for the effective implementation of all the elements contained in the GTS as it will free up existing roads within the city centre to facilitate the improvement of public transport, cycling and walking measures.

Provision of reliable transport infrastructure facilitates improved access to employment, education, vital services such as hospitals and amenities for all users. Reallocation of existing road space within the urban network will facilitate better provision of public transport which improves accessibility to all of the above services, in particular for lower income groups, vulnerable road users and the elderly. This in turn generates a healthier environment within the urban network where the population density is higher.

More sustainable and reliable infrastructure links to and from the Gaeltacht areas of the Western Region, enables Irish language speakers to remain in their native areas out of choice, and develop its economy in a way that is both language and culture friendly, halting the recent decline in population. This is of public interest as it is of national interest to preserve our heritage including our native language.

In tackling the city’s congestion issues, the proposed road development will provide a better quality of life for the city’s inhabitants and provide a much safer environment in which to live. By reducing the number of cars on the roads within the city centre, improving streetscapes, workers and school children are facilitated to commute using multi modal transport means. This includes travelling on foot, by bicycle and on the public transport system. As a result, more sustainable travel is supported and encouraged. This is of overriding public interest at a local level in Galway itself, but more importantly for the entire Western Region as Galway is at the core of the region and needs to be able to function efficiently to serve the region.

A detailed analysis of the impact of the proposed road development on society is presented in **Chapter 18, Human Beings, Population and Human Health**.

The need for the proposed road development from an Accessibility and Social Inclusion perspective is driven by a need to provide connectivity to the national roads via junctions to maximise the transfer of cross-city movements to the new road infrastructure. This will release the existing city centre zone from congestion caused by traffic trying to access a city centre bridge to cross the River Corrib, which allows reallocation of existing road space within the urban network, all of which will facilitates better provision of public transport with improved accessibility to all other transport modes for many more sectors of society.

3.7.6 Integration

Chapter 2, Planning and Policy Context sets out how the proposed road development is integrated into European, national, regional and local plans and policies.

The EU states that it is essential to take account of all aspects of sustainability (such as emissions, noise, land occupancy and biodiversity) and to base any action on a long-term vision for the sustainable mobility of people and goods i.e. sustainability of the entire transport system (ref EU Sustainable Development Strategy (EU SDS, 2001), reviewed 2009). The proposed road development facilitates the effective implementation of the GTS and the development of a sustainable transport solution for Galway City and its environs. The proposed road development also forms part of the TEN-T comprehensive road network in Ireland and is of strategic importance as it has a key role in delivering congestion relief and strengthening economic cohesion, as set out in **Section 2.2** and **3.6** of this EIAR.

At national level, the proposed road development fits into the Capital Plan as it serves to relieve urban congestion and provide connectivity to Galway so that Galway can contribute to the overall national development, refer to **Section 2.3.1** of this EIAR. "*Smarter Travel – A Sustainable Transport Future*" is a national policy framework which also drives the need for the proposed road development in order to secure a reallocation of road space for other modes such as public transport, cycling and walking, refer to **Section 2.3.2** of this EIAR. The proposed road development is identified as a project at a national level which is necessary to support economic recovery and sustainable growth because of its ability to improve mobility of people and goods into and out of Galway, and is vital to the economic recovery of the Western Region as a whole, which again is outlined in **Section 2.3.3** and **Section 2.3.4** of this EIAR. The proposed road development is also needed to deliver on national policy in respect of modal shift as it fits within an overall transport strategy which encourages a modal shift to a form of public transport that is associated with less emissions per capita than private car use, thus releasing and freeing the existing city centre zone for the reallocation to walking and cycling facilities and public transport, refer to **Section 2.3.5** of this EIAR.

These national policies are translated into regional and local policies as set out in the various development plans and local area plans, refer to **Section 2.4** and **Section 2.5** of this EIAR. The Galway Transport Strategy, which is the overall strategy for the next twenty years, requires delivery of an orbital route in order to deliver on all components proposed in the strategy and therefore, underpins the need for the proposed road development.

3.8 Overall need for the Proposed Road Development

The overriding need for the N6 Galway City Ring Road (GCRR) is underpinned by the fact that a modern economy requires world-class road transport infrastructure that is sustainable from an economic, social and environmental perspective. An efficient transport network which works for Galway City and environs will improve access to the Western Region, enhancing its attractiveness for inward investment and new employment opportunities and will contribute to enhanced competiveness by reducing transport costs.

The need to deliver the N6 Galway City Ring Road is supported in terms of policy from European to local level. The N6 GCRR is congruent with current transport policy and planning policy as set out in the various policy documents over the past number of years. Specific details for each of the policies and how the N6 GCRR complies with these and more local and regional policies are outlined in **Chapter 2, Planning and Policy Context**.

The specific project need is defined in terms of its potential to solve existing transport issues in Galway City and environs which include but are not limited to the following:

- Congestion throughout the city road network due to capacity failures at existing junctions
- Journey time unreliability and variability throughout the day
- Peak hour traffic delays
- By-passable traffic is in conflict with internal traffic
- Safety concerns as a result of traffic congestion
- Strategic traffic is in conflict with local traffic
- Inadequate transport links to access markets within the city
- Accessibility issues for Galway City and the Western Region as a whole
- Prolonged journey times and delays on the current bus network
- Reduced opportunities for safe and comfortable cycling
- Connectivity issues on the National and Regional road network
- Impact of traffic congestion on the city’s reputation, particularly with regard to inward investment

As a Gateway to the Connemara and the Western Region, connectivity and accessibility to and through Galway City is essential in aiding the region to revitalise, improve and develop into the future. Providing well developed transport links via roads, rail and air to the Western Region enables enterprises and the local economy of the west, to grow and develop as a viable alternative to the east coast corridor which is of significant public interest at a national level.

More sustainable and reliable infrastructure links to and from the Gaeltacht areas of the Western Region enables Irish language speakers to choose to remain in their native areas, and develop its economy in a way that is both language and culture friendly, halting the recent decline in population. It is of public interest at national level to preserve our heritage including our native language.

Galway City itself is a destination for strategic traffic to locations east and west of the River Corrib. The proposed road development addresses the need to connect these strategic destinations.

In tackling the city’s congestion issues, the proposed road development will provide a better quality of life for the city’s inhabitants and provide a much safer environment in which to live. By reducing the number of cars on the roads within the city centre and improving streetscapes, workers and students are facilitated to commute using multi modal transport means. This includes travelling on foot, by bicycle and on the public transport system. As a result, more sustainable travel is supported and encouraged and smarter travel policies both at a national level and local level are achieved. This is of overriding public interest at a local level in Galway itself, but more importantly for the entire Western Region as Galway is at the core of the region and needs to be able to function efficiently to serve the region.

The proposed road development will assist with the removal of traffic congestion from within Galway City and its environs by transferring existing and future traffic from the existing road network to the new road infrastructure. Relief of congestion in the city is essential to facilitate the improvement of the existing public transport network through measures such as the reallocation of road space, provision of a cross-city high frequency bus network, park and ride facilities, and or complementary traffic measures such as bus priority at junctions. Therefore, journey times will reduce and journey time certainty will increase for both public transport and private vehicle users. The reduction in traffic congestion will also help to realise other proposed actions in the Galway Transport Strategy because the existing road space can also be reallocated for cyclists and pedestrians. This will result in reducing the number of short commuter journeys by car by facilitating journeys by bicycle which are faster, cheaper, and more sustainable and generate health benefits.

Achieving the targets as set out in Smarter Travel policies will deliver a more attractive, vibrant and economic Galway City with associated health and environmental benefits, all of which are necessary for sustainable travel into the future. The proposed road development aligns with these policies and this project is necessary to firstly resolve the congestion issues which are currently restricting maximum implementation of the Smarter Travel policies by supporting sustainable transport policies for shorter commutes.

The need for an integrated transport solution which will relieve the congestion which is restricting Galway currently guided the development of the Galway Transport Strategy, of which the N6 GCRR is a key element, as this congestion is experienced by all travellers using various transport modes.

Therefore the functionality of the N6 GCRR is twofold. It provides for the strategic need of the TEN-T comprehensive road network and connectivity of Galway City and the West Region to the national road network, as well as providing a solution to relieve the city centre roads of unnecessary strategic traffic and providing the necessary road space for other modes of transport, namely walking, cycling and public transport. These two functions are complementary and the need for the N6 GCRR is supported by the policies below:

- Policies at European Union level, as expressed in the EU Sustainable Development Strategy, at national level in the Climate Action and Low Carbon Development Act 2015 and subsequent policies at regional and local levels, have identified the need for a sustainable transport solution to the type of traffic issues currently experienced in Galway City and its environs which can be alleviated through the delivery of the Galway Transport Strategy of which the N6 Galway City Ring Road is a key element. It is also consistent with Smarter Travel, A Sustainable Transport Future, 2009 and Irelands National Cycle Policy Framework, 2009 to 2020

- Policies at European Union level, as expressed in the TEN-T Regulations, supplemented by policies at national, regional and local levels, have identified an objective for a high quality road to connect Galway to the core Trans-European road network
- Connectivity and accessibility to markets, employment and tourism offerings in Galway City and its environs, underpins the economic development of the Western Region as a whole, with Galway City as the hub
- The proposed road development is consistent with the recommendations, priorities and objectives as set out in the DTTaS 2015 investment framework and the Capital Plan, as it seeks to deliver the N6 Galway City Ring Road, address urban congestion in Galway City, and enhance national development through improved connectivity to Galway
- The proposed road development is a component of an overall transport strategy driven by a need to relieve traffic congestion in the urban centre of Galway which in turn facilitates a modal shift to public transport, cycling and walking

The N6 GCRR represents the best solution to the transport issues described above and supports more sustainable travel for the following reasons:

- It will provide a **strategic route,** forming part of the TEN-T comprehensive network, across the River Corrib without the need to go through the city
- This strategic route will be of a **high standard** cross-section and will provide the **capacity required for the strategic traffic** serving the city and connecting the county to the national network
- Improves **connectivity to the Western Region** i.e. the county areas and hinterland beyond the city zone and provides the necessary connectivity to all the national roads and the Western Region and for those living within Galway and the rest of the country
- Moreover, access to this strategic route is limited to the junctions which will **protect the road asset in the future** and means that its **capacity is secure**
- This route is of European importance given that the **TEN-T comprehensive network designation** extends west of the city to the terminus of N6 GCRR and will provide a link to the Western Region of the standard of a comprehensive route in accordance with TEN-T
- Provides for **strategic traffic accessing Galway City** and connectivity with zones of traffic generators and attractors
- This route provides connections to **essential city links** to better distribute traffic
- It meets the functionality of the **road component of the overall intermodal transport solution** and enables the reallocation of existing road space within the city to public transport and smart mobility measures and is part of a

sustainable holistic transport solution. Thus, facilitating a **more efficient public transport system** and the provision of a **multi-modal choice of travel**

- **Improves safety** levels for all public road users
- By **tackling the city's congestion issues**, it will provide a **better quality of life** for the city's inhabitants and provide a much **safer environment** in which to live
- By **reducing the number of cars** on the roads within the city centre and improving streetscapes, workers and students are facilitated to commute using **multi-modal transport means**. This includes travelling on foot, by bicycle and on the public transport system
- Provides connectivity to the national roads via junctions to maximise the transfer of cross-city movements to the new road infrastructure, thus **releasing and freeing the existing city centre zone from congestion** caused by traffic trying to access a city centre bridge to cross the River Corrib
- Attracts traffic from the city centre zone thus facilitating reallocation of road space to public transport leading to **improved journey time reliability for public transport**
- **Caters for the strong demand** between zones on either side of the city
- Provides additional river crossing with **connectivity back to the city** either side of the bridge crossing
- Facilitates **improved city centre environment** for all due to reduced congestion, thus **encouraging walking and cycling** as safe transport modes

4 Alternatives Considered

4.1 Introduction

The EIA Directive as amended by Directive 2014/52/EU requires that the Environmental Impact Assessment Report (EIAR) contains *"a description of the reasonable alternatives studies by the developer, which are relevant to the project and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the project on the environment[1]"*. (Article 5(1)(d).

The EIAR is to also *include "a description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics and an indication of the main reasons selecting the chosen option, including a comparison of the environmental effects"* (Annex IV).

Also, pursuant to section 50(2)(d) of the Roads Act 1993 (as amended) the EIAR (or EIS as then was under the Roads Act) is to contain *"an outline of the main alternatives studied by the road authority concerned and an indication of the main reasons for its choice, taking into account the environmental effects"*.

This chapter of the EIAR describes the reasonable alternatives considered in terms of project design, technology, location, size and scale studied and the main reasons for the selection of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, including a comparison of the environmental effects of the alternatives of the proposed road development, to address the very serious transport issues facing Galway City and its environs. This assessment of alternatives is also fully compliant with the provision of the Roads Act 1993 (as amended).

Following on from the initial feasibility study, taking cognisance of the decision of An Bord Pleanála and the Supreme Court and the opinion of the European Court of Justice on the 2006 GCOB Scheme and the key constraints of the Lough Corrib candidate Special Area of Conservation (cSAC) the alternatives which were considered are outlined below:

- 'Do-Nothing Alternative'
- 'Do-Minimum Alternative': which includes road and non-road schemes, including smart mobility measures, which have been committed or are likely to proceed in the short term
- 'Do-Something Traffic Management Alternatives': This alternative was based on all feasible measures, options and schemes identified as part of the studies for the Galway Transport Strategy

[1] Article 5(1)(d) of the EIA Directive, as amended by Directive 2014/52/EU

- 'Do-Something Road Based Alternatives': includes initial road based alternatives discounted, upgrading of the existing road infrastructure and River Corrib crossing alternatives

An outline of this chapter is as follows:

- **Section 4.2** gives an overview of the traffic issues
- **Section 4.3** summarises the key constraints to developing a transport solution
- **Section 4.4** describes the 'Do-Nothing Alternative'
- **Section 4.5** describes the 'Do-Minimum Alternative'
- **Section 4.6** describes the 'Do-Something Traffic Management Alternatives' including improvement of Public Transport only
- **Section 4.7** describes the 'Do-Something Road Based Alternatives'
- **Section 4.8** summaries the optimisation of the preferred route corridor of the road based solution
- **Section 4.9** provides a summary of the optimum transport solution

4.2 Overview of Traffic Issues

In considering alternatives, it was essential at the outset to identify the cause of the existing traffic problems and issues within Galway City and its environs in order to develop an appropriate solution to the problem. A key driver for this process was to minimise the impact to the natural and built environment.

The initial work in understanding the cause of the transport issues focused on gathering information and data from a wide variety of sources and utilising various mechanisms to examine the existing transportation issues, including a review of the previous 2006 GCOB Scheme, current policy documents, 2011 Census data for Galway City and its environs including Galway County and the Western Region and site visits in Galway. The transport issues were reviewed against the 2016 Census data also and it was noted that Galway City is continuing to grow and the transport issues remain unchanged. This is detailed in **Chapter 3, Need for the Proposed Road Development** and **Chapter 6, Traffic Assessment and Route Cross-Section**.

The transport issues facing Galway City and its environs are summarised below:

- Congestion throughout the city road network
- Over capacity of existing junctions
- Journey times unreliable due to uncertain quantum of delay
- Journey time variability throughout the day
- Peak hours traffic delays
- By-passable traffic is in conflict with internal city traffic
- Strategic traffic is in conflict with local traffic

- Inadequate transport links to access employment centres/shopping/commercial districts within the city
- Inadequate transport connections from Galway onwards to Connemara
- Lack of accessibility to the Western Region as a whole
- Lack of available space to facilitate the improvement of non-motorised modes of transport

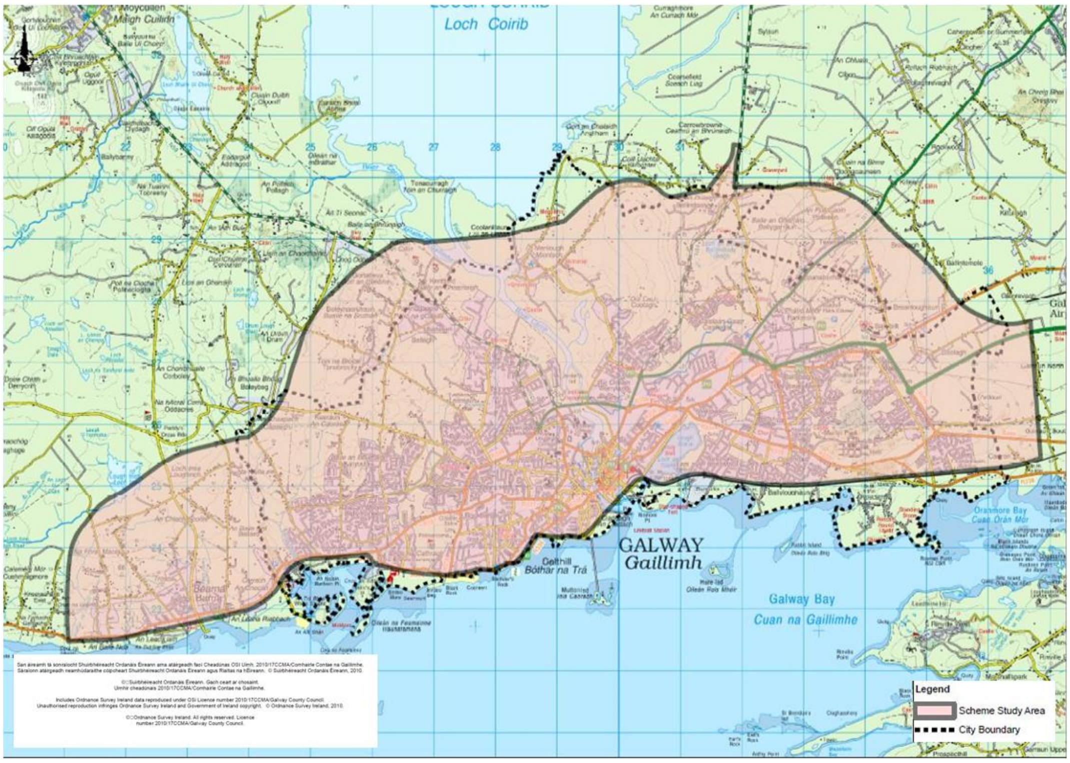
Essentially, traffic congestion in Galway City and its environs is crippling and stifling city living as well as cutting off access from the wider region to employment and services in the city. The total breakdown of the transport network in Galway occurs on a frequent basis as there is no resilience in the network e.g. wet afternoon, road maintenance, vehicle collision and signal outage. This random unpredictable shutdown of Galway's transport network costs millions and has the real potential to prohibit Galway functioning as a city or economic engine for the Western Region.

The Galway Transport Strategy (GTS) as discussed in **Chapter 3, Need for the Proposed Road Development** has identified a transport solution to create a safer, smarter and sustainable transport system for Galway City and its environs taking into account travel demands, existing infrastructure and environmental constraints. Alternatives considered will be assessed against this overarching strategy in place for Galway.

4.3 Significant Constraints

A constraints study was undertaken within the study area shown in **Plate 4.1**, which essentially is the area within which it is possible to develop a transportation solution for Galway City and its environs. Constraints of a physical and environmental nature that may affect the development of a possible solution were identified within the study area.

Plate 4.1: Study Area



As part of the Constraints Study, public consultation sessions were held in July 2014. Comments from the public were invited and the results of the consultation were recorded in the Constraints Study.

The issues that were considered in the Constraints Study included:

- the existing infrastructure, land use, topography and physical features
- identification of sites or areas of environmental significance or sensitivity
- planning, development and socio-economic character
- technical constraints

The constraints study identified that there are significant constraints for developing new transport infrastructure in Galway which arise principally due to (i) the physical form of the city (ii) the limited space available (iii) the built environment and residential areas on both sides of the River Corrib, and (iv) the presence of designated sites of international significance.

These constraints are described in more detail below:

- The development of low density residential suburban areas in a linear pattern has led to reliance on private car usage in Galway as a means of travel and makes it difficult to develop an economically efficient public transport solution
- Galway City is divided by the River Corrib as it flows between Lough Corrib and Galway Bay with significant trip attractors, employment centres, education centres and residential areas located on both sides of the river

- Lough Corrib forms a natural division between the east and west of County Galway and the distance between Lough Corrib and Galway Bay is only 4.5km[2] within which lies Galway City and its population, very much at the heart of County Galway
- The city is located in the middle of areas which are rich in natural heritage with a wealth of natural habitats. This has resulted in significant areas around Galway City being designated of international importance

The physical form of the city in terms of the built and natural environment and residential areas on both sides of the River Corrib, together with the limited available space between the lake and the bay, plus the presence of the designated sites presents significant constraints for developing new infrastructure for the city. The presence of these constraints focuses attention on the importance of considering reasonable alternatives in order to minimise the impact on the human environment and the designated sites.

These significant constraints are depicted on **Plate 4.2** below.

A full description of the constraints study is documented in *Chapter 4* of the *N6 Galway City Transport Project Route Selection Report*.

[2] Distance measured from south shore of Lough Corrib to Spanish Arch at Galway Docks

Plate 4.2: Significant constraints

4.4 'Do-Nothing Alternative'

The need for the proposed road development is set out in **Chapter 3, Need for the Proposed Road Development**, with the requirements for intervention at a European, National, Regional and local level evident to address the transport issues currently experienced in Galway City and its environs.

The 'Do-Nothing' alternative comprised an examination of the existing transportation network and infrastructure and its ability to meet future transportation demands, in the absence of any upgrade works other than routine maintenance. This option did not provide for any investment in the transportation network and infrastructure of Galway City and its environs.

The 'Do-Nothing' alternative will only compound existing significant congestion issues experienced across the city, particularly during peak hours, which is impacting on the economic capability of the city. The road and street network of Galway City is ill-suited to the high traffic flows currently prevalent and contributing to increased congestion and delay, affecting quality of life and impacting on the functionality of the city. The effects of this congestion and bottlenecks extend to the wider county and region, due to the large number of people commuting daily for work or education to the city from the surrounding towns, villages and rural areas. The congestion and infrastructural bottlenecks impact the connectivity of the Western Region to the rest of the country and the internal markets of the EU.

The assessment for the 'Do-Nothing' alternative concluded that it:

- would not offer a positive economic benefit as it would not serve to reduce the existing congestion which is the cause of the journey time problems
- would result in a further decrease in efficiency of the transportation infrastructure over time
- would not offer any improvement to safety as it is essentially a continuation of the existing situation whereby many junctions make no provision for vulnerable road users
- would not benefit from smart mobility/public transport initiatives as it does not facilitate any improvement on these fronts
- does not involve any construction works, and therefore does not directly create significant benefits or dis-benefits to the environment. However, this scenario may lead to increased traffic congestion and its associated environmental impacts
- would not facilitate the implementation of the Galway Transport Strategy measures

Additionally, Galway City and County Councils have identified various projects and plans which are likely to be implemented in the short-term, giving certainty to the fact that the 'Do-Nothing' option in the overall sense of undertaking no transportation improvement measures is not a real option. The identification of these schemes rendered the 'Do-Nothing' option redundant and it was discounted from further consideration. The committed schemes are considered below in the 'Do-Minimum' alternative.

It is noted that for the purposes of the EIA, the 'Do-Nothing' alternative where the proposed road development does not progress in isolation also needs to be considered and this is what is assessed in the subsequent chapters of this EIAR. The assessment for this 'Do-Nothing' alternative concluded that it:

- would not offer a positive economic benefit as it would not serve to reduce the existing congestion which is the cause of the journey time problems
- would result in a further decrease in efficiency of the transportation infrastructure over time
- would not offer any improvement to safety as it is essentially a continuation of the existing situation whereby many junctions make no provision for vulnerable road users
- would not benefit from smart mobility/public transport initiatives as there would be no new crossing of the River Corrib and it does not facilitate any improvement on these fronts
- does not involve any construction works, and therefore does not directly create significant benefits or dis-benefits to the environment. However, this scenario may lead to increased traffic congestion and its associated environmental impacts
- would not facilitate the full implementation of the Galway Transport Strategy measures

4.5 'Do-Minimum Alternative'

The 'Do-Minimum' alternative followed on from the 'Do-Nothing' alternative.

The traditional definition of the 'Do-Minimum' alternative could not be applied to the transport issues in Galway City and its environs:

"The Do-Minimum alternative will generally comprise an investigation of the feasibility of an online upgrade of the existing route that would be capable of delivering the required levels of service and safety in accordance with the applicable design standards[3]"

This definition had to be modified due to the planned and likely investment in transportation infrastructure. A more realistic 'Do-Minimum' alternative was one which included planned and likely transportation schemes, including numerous smart mobility measures, and provided a realistic overview of the transportation networks of Galway City and its environs should major investment not be provided.

In addition, the feasibility of an on-line upgrade of the existing route is assessed as a 'Do-Something' alternative as it is quite an extensive scheme and is excluded from the 'Do-Minimum' alternative.

Therefore, the 'Do-Minimum' alternative involved an examination of the existing transportation networks and infrastructure and existing policy and plans for Galway

[3] National Roads Authority Project Management Guidelines 2010

City and its environs. In this scenario, the existing transportation networks and infrastructure combined with likely and committed transportation schemes were examined to determine their ability to meet future transportation demands.

Likely and committed transportation schemes were identified following consultation with Galway City Council, Galway County Council, the National Transport Authority and Transport Infrastructure Ireland. Transportation schemes in the 'Do-Minimum' alternative include:

- Merlin Park Hospital Bus Access
- N59 Dangan Upgrade
- Kirwan Roundabout Upgrade
- Terryland Right turn lane on the existing N6
- Browne Roundabout Upgrade
- Cross-Middle St. Pedestrianisation
- Dock Road Corridor
- Dublin Road Bus Lane
- Monivea Road Corridor
- M17/M18 Motorway
- N59 Maigh Cuilinn (Moycullen) Bypass

The assessment of the 'Do-Minimum' alternative concluded that:

- Whilst it would achieve a more economic benefit than the 'Do-Nothing' alternative it would not serve to reduce the existing congestion sufficiently such that the overall transportation issues would be solved and a significant economic benefit would not be achieved
- The Do-Minimum will not achieve sufficient results to ensure a further decrease in efficiency of the transportation infrastructure over time would not arise. In the Do-Minimum alternative, the total network delay in the morning peak hour rapidly increases by 70% relative to the Base Year[4], far more than the increase in trips, indicating capacity issues on the network
- Whilst the individual projects would contribute to improving safety at a local level, overall the Do-Minimum alternative would not offer a significant improvement to safety as traffic will continue to increase on the existing network without any release of capacity in the highly trafficked urban areas
- Whilst the individual projects would contribute to benefiting some public transport/smarter travel initiatives at a local level, overall the Do-Minimum alternative would not achieve sufficient results to enable the full implementation of improvements to the public transport and cycling alternatives as capacity will be restricted
- This alternative does not relieve sufficient traffic congestion and the associated environmental effects in the city centre

[4] Base Year is the year for which the baseline traffic data is based on.

- would not facilitate the complete implementation of the Galway Transport Strategy measures

The 'Do-Minimum' alternative was discounted as it does not meet the project objectives for the reasons noted above. The 'Do-Minimum' alternative was compared also against the Design Year[5] and the findings listed above were the same.

4.6 'Do-Something Traffic Management'

The Traffic Management Measures alternative represents alternatives that seek to respond to transportation problems by maximising the value of existing infrastructure without construction of major new infrastructure. The Traffic Management Measures alternative can include some or all of the following:

- Local road safety improvements
- Fiscal or traffic control measures to manage demand
- Public transport priority, capacity and/or public transport services
- Improvements to pedestrian and/or cycling provision
- Intelligent Transport Systems (ITS) to improve reliability, safety and operation capacity

4.6.1 Public Transport Only Option

The 'Public Transport Only' element of this alternative was developed and analysed as part of the initial studies on the N6 Galway City Transport Project (GCTP). This alternative includes all measures, options and schemes identified by Galway City Council in conjunction with the National Transport Authority as a result of the recommendations of the Galway City Council study entitled *Galway Public Transport Feasibility Study* of 2010, namely:

- A Bus Rapid Transit (BRT) operating at a 10-minute frequency from Knocknacarra to the West, through the city centre, to Oranmore in the East
- All existing city bus services increased to 10-minute frequency
- Bus priority measures at signalised junctions along the BRT corridor
- Re-allocating road space on the Salmon Weir Bridge from general traffic to Public Transport only
- Light Rail with bus feeders and complementary services

It should be noted that the Galway Public Transport Feasibility Study from 2010 assumed that the Galway City Outer Bypass (GCOB) as proposed by the 2006 planning application was in place, thereby making it possible to consider reallocation of road space on the Salmon Weir Bridge. However, this Public

[5] Design Year is 15 years after the year of opening the proposed road development (2039)

Transport Only Alternative as modelled in the initial studies on the N6 GCTP does not include for the 2006 GCOB.

The mode share analysis shows that there is a low public transport mode share of just 5.0% in the 2012 Base Year. This reduces slightly to 4.9% in the 2034 Do-Minimum due to increased car ownership offsetting the increase in congestion. The 'Public Transport Only' alternative increases public transport mode share to 5.8% in 2034, which is a 17% increase in public transport trips relative to the Do-Minimum 2034. However due to the overall low public transport mode share, this represents less than a 1% reduction in car trips. Full implementation of the 'Public Transport Only' alternative, as defined above, has a negative impact on the congestion and the key performance indicators identified to test performance vis-à-vis the project objectives. Analysis shows that it results in a 2% increase of delay to every vehicle journey across the key routes identified as the key performance indicators, when compared to the 2019 Do-Minimum. The 'Public Transport Only' alternative does not provide an adequate transport solution as it does not reduce congestion levels in the city when considered in isolation. Therefore, the 'Public Transport Only' alternative does not represent an effective 'Traffic Management Alternative' that responds to transportation problems as it does not resolve these problems in isolation. Analysis on the Public Transport Only Option demonstrated that it does not provide a solution in isolation, however it does form part of the overall holistic transportation solution and is included in the Galway Transport Strategy.

4.6.2 Galway Transport Strategy

Through consultation with key stakeholders including TII, NTA, Galway County Council and Galway City Council, it was agreed that a wider integrated transport strategy was required for Galway to identify the level of service requirements for each mode of transport; including walking, cycling, public transport and private vehicle. The more comprehensive 'Traffic Management Alternative' culminated in the Galway Transport Strategy which provides Galway City and its environs with a clear implementation framework for transportation over the next 20 years. This is an incremental strategy which seeks to implement sustainable transport solutions to manage traffic demand. A portion of these incremental measures will provide some relief to the traffic problems experienced in Galway City and its environs however, to fully realise the overall transport solution all measures are required.

The development of this strategy involved reviewing and consolidating various existing transport proposals, including the bus study noted in **Section 4.6.1** above, and a light rail study amongst other measures to form a coherent and integrated transport strategy for Galway City and its environs. It followed a structured approach and methodology through a process of:

- Assessment of existing and projected future levels of travel demand, journey types to be served, and evaluation of existing levels of transport service provision
- The development and testing strategy options by individual transport mode and in combination to meet forecasted levels of travel demand

- The development of specific proposals which were subsequently brought together under the overall strategy

This transport strategy seeks to deliver an integrated network of ‘links’ (routes) and ‘nodes’ (stops and interchange locations) along which people can travel seamlessly, changing corridors and modes as necessary to make their journey. The most suitable travel modes to address the travel demand for different types of journey was examined so that the measures developed are targeted at particular movements (rather than adopting a universal mode-share target for all journeys in and through Galway). The shape and operational characteristic of the network for each mode is fundamental in achieving an appropriate usage of that mode. This means that unless the network links match the journeys people want to make then usage of the network will be limited, regardless of the quality of the service in question.

The range of different journey types in Galway City and its environs requires bespoke solutions for each travel mode in order to develop an integrated package of measures such that the ‘sum of the parts’ improves transport conditions and journey choices for all in Galway. A synopsis of the range of solutions for each travel mode is outlined below:

- Pedestrians and cyclists: Traffic within the city centre needs to be managed to make it a more comfortable environment for pedestrians and cyclists
- Cyclists: Provision of high quality dedicated cycling facilities and additional measures giving priority to cyclists are required to encourage an uptake in cycling both for commuting and as a leisure activity in the city and surrounding areas
- Public Transport: Access through the city for public transport must be reliable at all times of the day to achieve a travel mode shift in favour of public transport. To achieve this, it is necessary to reduce vehicular movement through the city centre, to reduce vehicle speeds in the core city centre area, and to prioritise active modes (walking and cycling) and public transport in the city centre. The strategy therefore includes for routing of traffic which currently passes through the centre (to reach edge-of-centre locations) to more suitable orbital routes around the core city centre area
- Cross-city route: For journeys not possible by non-car modes, a reliable cross-city route is necessary. Providing additional orbital traffic capacity will increase the opportunities for re-allocation of existing road space for use by pedestrians, buses and cyclists, which is identified as a key traffic management objective of the strategy
- Parking: Availability of on-street parking will be reduced and access routes to off street parking facilities will be rationalised and managed to minimise car circulation within the city centre. A parking pricing structure will be put in place which sets the cost of city centre parking at a level that does not undermine travel by public transport

It is important to note that the choice of mode for public transport (e.g. bus, light rail, demand responsive) is to a large extent secondary to the development of a network with appropriate coverage and frequency. This aspect is well described in a good practice guide[6] as follows:

"Getting the network right is usually more important than the often debated and studied choice between bus and rail systems. Mode selection for new parts of the network should normally come after an overall network strategy has been created. Then the roles of different bus and rail systems can be conceived as specialised tasks within the network, and the different advantages of the various public transport modes and types of lines may be more easily exploited."

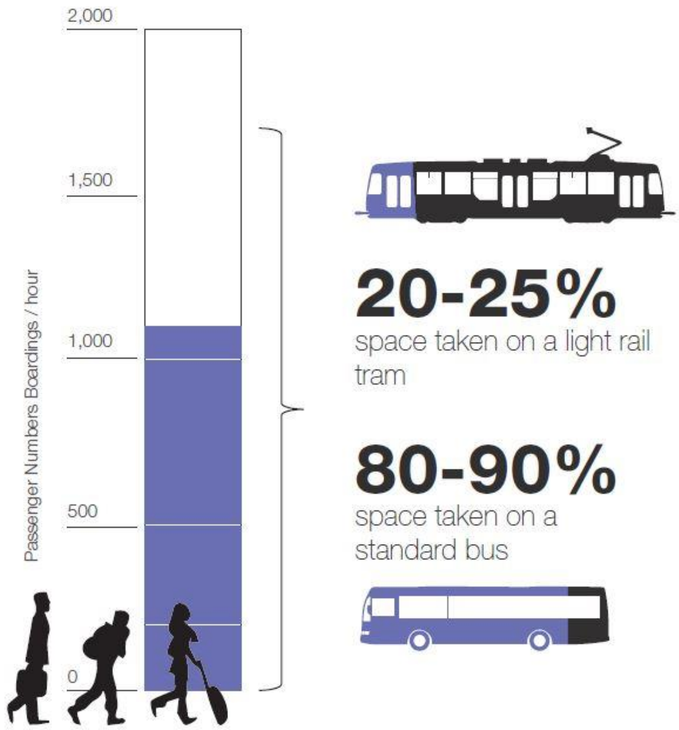
As such, the type of public transport network configuration that best suits Galway, both in terms of alternative modes and network configuration was considered and assessed in detail. The layout identified by the GTS was developed as a function of catchment areas based on residential and commercial land use, in order to maximise the potential number of passengers and journeys. The most appropriate mode for public transport in Galway City and its environs was assessed using the Western Regional Model (WRM) to test the potential passenger use of high frequency public transport services. This looked at bus-based or light rail-based options on the busiest corridors in Galway, with additional buses on other corridors. The results provide a basis for identifying the public transport system best suited to Galway City and its environs.

Transport modelling to test the potential passenger use of high frequency public transport services along the busiest corridors in Galway, looking at a bus-based or light rail-based options on these indicated that with high-frequency services in place, the maximum single directional passenger demand would only be approximately 1,100 over a 1-hour period (in the AM Peak).

As illustrated in **Plate 4.3**, this broadly equates to 80-90% of the passenger capacity of a frequent bus service, and less than 25% of the capacity of a frequent light rail service.

[6] Network Design for Public Transport Success – Theory and Examples, Institute of Transport Economic/Civitas

Plate 4.3: Estimated Maximum Occupancy of Public Transport System Options



In addition, the typical carrying capacity of a range of public transport systems, from the standard single-decker bus to a heavy rail system, is shown in

Table 4.1. It can be seen that frequency is the key factor in maximising the carrying capacity of any public transport system. For example, the table below shows that a double decker bus operating at a 10-minute frequency can carry up to 450 passengers an hour, which is close to the carrying capacity of a light rail system operating once every 30 minutes (518 passengers).

Table 4.1: Typical Carrying Capacities of Public Transport Systems

	Standard Single Decker Bus	**Standard Double Decker Bus**	**Articulated Bus / Tri-Axle Double Decker Bus**	**Light Rail**	**Heavy Commuter Rail Service**
Design Capacity (Persons)	**30 People**	**75 People**	**102 People**	**259 People**	**409 People**
Frequency (minutes)					
30	60	150	204	518	818
20	90	225	306	777	1227
15	120	300	408	1036	1636
10	180	450	612	1554	2454

	Standard Single Decker Bus	Standard Double Decker Bus	Articulated Bus / Tri-Axle Double Decker Bus	Light Rail	Heavy Commuter Rail Service
Design Capacity (Persons)	**30 People**	**75 People**	**102 People**	**259 People**	**409 People**
Frequency (minutes)					
6	300	750	1020	2590	4090
5	360	900	1224	3108	4908
4	450	1125	1530	3885	6135
3	600	1500	2040	5180	8180
2	900	2250	3060	7770	12270

The figures set out in **Table 4.1** indicate that a light rail service would provide capacity far in excess of what is practically required in Galway City and its environs. Hence, when considering the greater cost of building and operating light rail services at the same frequency as bus services, it is clear that bus-based public transport represents the most appropriate system for Galway City and its environs over the period considered in the Galway Transport Strategy.

It is important that the proposed bus network facilitates a high level of public transport accessibility across Galway City by provision of a network of high-frequency cross-city services with guaranteed and reliable journey times. It must be supported by strong potential for interchange between services so that it will provide linkages from most parts of the city and will connect with transport services from suburban towns.

The public transport network and type of system (or mode) is also dependent on a number of further considerations:

- **Street Network:** Galway is an historic city and its layout and road network reflect a city that has developed over many years with some roads and streets, especially in the city centre, being very narrow, resulting in turning movements being difficult for some modern public transport vehicles to navigate.
- **Network or Corridor:** The most successful public transport networks and services are generally those that offer a consistently high frequency throughout the day on a network of services, and hence can attract a broad variety of trip purposes such as commuter trips, trips to education and trips for retail and leisure activities.

It was concluded that a high-quality bus-based public transport service will most appropriately cater for the forecasted passenger demand and provide significant flexibility in terms of network options and the ability to integrate with other modes. In particular, a bus-based public transport network can cater for high volumes of demand along combined corridor sections (for example through the city centre) whilst diverging out to efficiently provide greater direct catchment within less-dense suburban areas of Galway.

Having identified the most appropriate form of public transport solution to serve Galway, a further key consideration was the form of network upon which bus services should be reorganised and developed. The primary consideration was whether concentration should be given to increased orbital bus services (for example, via the Quincentenary Bridge) versus services through the city centre.

Analysis from the transport modelling undertaken confirmed the patronage for an orbital service would be approximately half of what would use an equivalent service routed via the city centre. This outcome clearly indicated that cross-city bus services via the city centre will be both more attractive to passengers and more financially viable than operating orbital services. This guided the final bus network and service pattern adopted in the GTS, which is currently being developed by the NTA and Galway City Council.

The reallocation of road space to public transport in the city centre will be accompanied by an associated improvement in the public realm as improvement to the quality of the receiving environment for passengers' onward journeys on foot is viewed as a component of the public transport offering. Finally, to shift the focus within the city centre to walking, cycling and public transport and measures to manage demand on the transport infrastructure are needed to enhance the function of the city for these users. This may include measures such as managing and controlling the availability and cost of parking, restricting traffic flow from certain streets, reducing speed limits, providing additional pedestrian crossings at key locations and a reduced emphasis on facilitating through-traffic.

A number of scenarios were developed, with an increasing level of provision and investment in each subsequent scenario. These scenarios were tested in the Western Regional Model (WRM) as discussed in **Section 3.2.2** of **Chapter 3**, **Need for the Proposed Road Development** and the scenario which included the proposed road development with the other transport measures performed better overall in providing a safer city centre and a more socially inclusive transport network by improving accessibility. This scenario includes the following measures:

- An upgraded and integrated public transport network
- City centre public transport prioritisation, including the use of the Salmon Weir Bridge solely for public transport
- Improvements to walking and cycling infrastructure and priority, including an additional city centre crossing of the River Corrib solely for use by non-motorised vehicles
- Integrated Park & Ride facilities
- Demand management measures
- Full orbital bypass of Galway City Centre from the N6 to the R336 Bearna Road linking the N6, N83[7], N84 and N59 national roads

As the sum of the individual measures in the Galway Transport Strategy (GTS) effectively comprises the overall holistic transport solution for Galway, a sensitivity

[7] Formally known as the N17 Tuam Road.

test was carried out on the effective implementation of the GTS against each of the "Do-Something" scenarios of the same year. As the GTS is a 20-year strategy, this sensitivity test has only been carried out in 2039, Design Year. The results of this sensitivity test are presented in **Section 6.6.3.1** and show a similar pattern to results for the test results for the DS Core Scenario tests (Do-Minimum and Do-Something Scenarios for 2024 Opening Year and 2039 Design Year). In general, the opening of the proposed road development, in conjunction with the other measures proposed in the GTS, has a positive impact on the majority of Journey Time routes analysed, particularly in the AM and PM peak periods.

The results below show more negative impacts on journey times than the DS Core Scenario tests. The reason for this is that the GTS contains a number of proposals which limit capacity on the city centre network, as a result of increased active mode and public transport priority measures in the city centre, and therefore adds delay to certain sections of the network. Also, traffic management arrangements proposed in the GTS result in the lengthening of some journey time routes which in turn adds to the total journey times.

In order to implement the level of service required for each mode of transport, including walking, cycling, public transport and private vehicle as outlined in the GTS, a new crossing of the River Corrib is required. Alternative options for the new River Corrib Crossing were considered as part of the road component for the N6 GCTP. These alternatives are outlined below in **Section 4.7**.

As noted above the GTS is an incremental strategy which seeks to implement sustainable transport solutions to manage traffic demand. A portion of these incremental measures will provide some relief to the traffic problems experienced in Galway City and its environs however, to fully realise the overall transport solution a new crossing of the River Corrib is still required in order to facilitate the public transport options identified and the modal shift envisaged in the GTS.

4.7 'Do-Something Road Based Alternatives'

As noted in **Section 4.3** the Lough Corrib forms a natural division between the east and west of County Galway and the distance between Lough Corrib and Galway Bay is only 4.5km. Numerous alternatives for connecting the east and west of Galway City and County were considered. Alternatives across Lough Corrib and Galway Bay or a tunnel from the far west of the study area to the east were all considered and discounted as outlined below in **Section 4.7.1**. Alternatives for a new crossing of the River Corrib were considered and these alternatives are outlined in **Section 4.7.2**. The appraisal for the selection of the preferred river crossing and associated route for the preferred road based alternative is outlined in **Section 4.7.3**.

4.7.1 Initial Alternatives Discounted

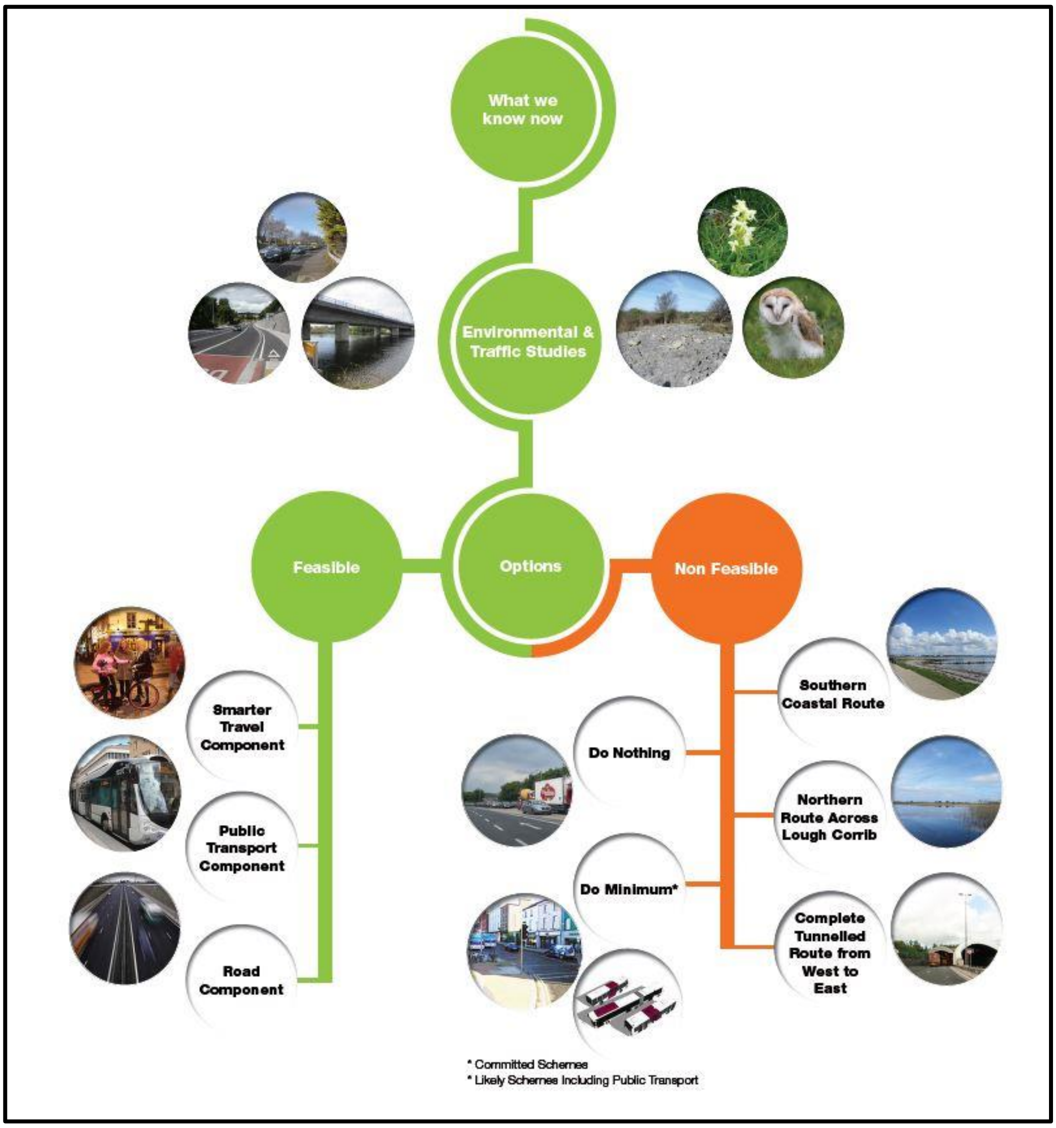
An assessment of the following alternatives discounted them from further consideration as they were deemed not to meet the project objectives outlined in **Chapter 3, Need for the Proposed Road Development**:

- Lough Corrib Route Options

- Coastal Route Options
- Tunnel over project extents

These discounted options were presented graphically at Public Consultation No. 2 in **Plate 4.4** below.

Plate 4.4: Discounted Options – Public Consultation No. 2



4.7.1.1 Lough Corrib Route Options

The alternative of linking the eastern and western areas of County Galway by crossing Lough Corrib on a viaduct was considered.

Lough Corrib has significant ecological importance, being part of the Lough Corrib cSAC and Lough Corrib SPA, and is an area of immense scenic amenity. The ecological constraints associated with this alternative make crossing Lough Corrib by viaduct difficult. Any crossing of this lough would involve a significant structure making its incorporation into the landscape extremely difficult and it would have significant visual impacts.

Traffic analysis shows a strong demand coming from all over the county to the city and back. It also highlights the fact that, the further the proposed route for the road based alternative is from the city the less attractive it would potentially be to motorists and the less impact it would have on reducing the existing transportation issues of the city. Any proposal to introduce a viaduct across Lough Corrib would at a minimum be located 4.5km from the existing cross city route – the N6 and R338. There is therefore limited benefit from a traffic perspective to locating a new west to east connection across Lough Corrib.

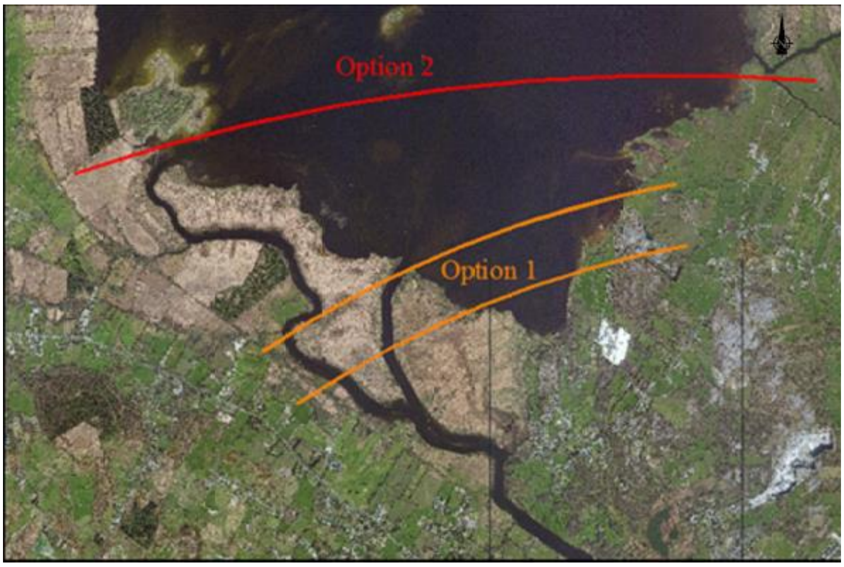
Crossing Lough Corrib by viaduct would not meet the project objectives for the following reasons:

- It would not reduce journey times on key routes
- It would not provide a cost effective project
- It may have a significant impact on Lough Corrib cSAC and Lough Corrib SPA
- It would not take due cognisance of the importance of the existing landscape
- It may not support the development of critical mass regional population centres as it will not support the development of Galway City as a Gateway

As alternatives were available which have a lesser impact on the environmental constraints, which would have a higher patronage and provide a greater benefit to the local economy than a crossing of Lough Corrib, further examination of a viaduct crossing on Lough Corrib was discounted.

The Lough Corrib Route Options are shown in **Plate 4.5** below.

Plate 4.5: Lough Corrib Route Options



4.7.1.2 Coastal Route Options

The alternative of linking the eastern and western areas of County Galway with a route along the coastline was considered.

The Coastal Route Option required a significant bridge structure across the mouth of Galway Harbour which would likely impact on boat traffic and the operation of the harbour and docks area. The bridge would be elevated and visible from all areas surrounding the harbour including the Claddagh, South Park and the Spanish Arch, all of which comprises an area of immense scenic beauty and high amenity. It would impact visually on the landscape of both the city and Galway Bay and required at least one crossing of the Dublin to Galway railway line.

The ecological constraints associated with this alternative also made the Coastal Route Option difficult. Galway Harbour has environmental importance including Galway Bay Complex cSAC and Inner Galway Bay SPA.

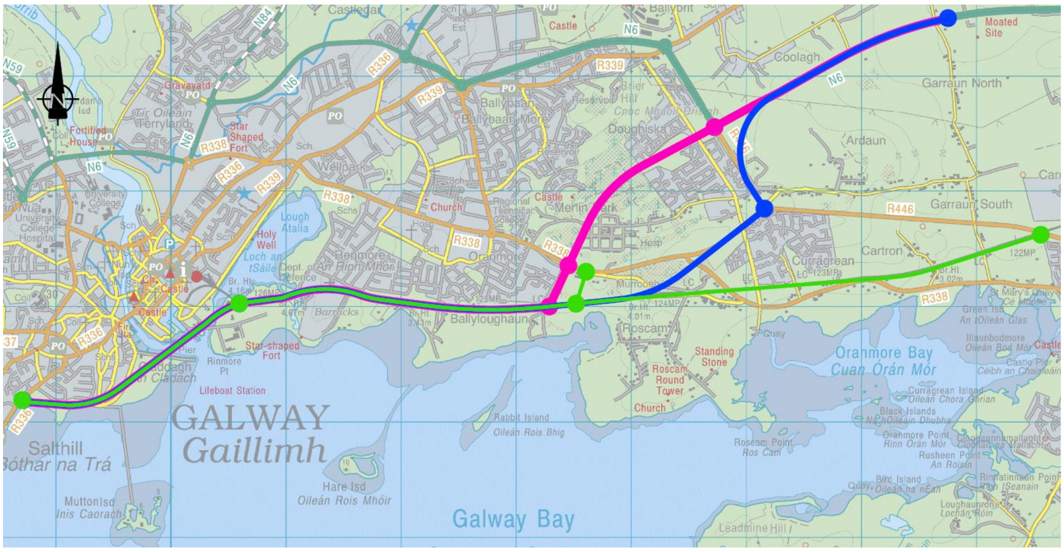
This alternative did not meet the project objective to provide a connection to some or all of the national roads leading into the city, namely the N59, N84, N83, and N6/M6 to the east, in order to create an integrated national road network around the city. This could potentially result in no improvement on journey times and journey time reliability which is another project objective.

In summary, a Coastal Route Option did not meet the project objectives for the following reasons:

- It would not provide journey time reliability on the key routes
- The crossing of the harbour may have a significant impact on Galway Bay Complex cSAC and Inner Galway Bay SPA
- The crossing of the harbour would not take due cognisance of the importance of the existing landscape

As alternatives were available which have a lesser impact on the environmental constraints, which would have a higher patronage and better meet the project objectives than a coastal route, further examination of this alternative was discounted.

Plate 4.6: Lough Corrib Route Options



4.7.1.3 Tunnel Over Project Extents

Following on from the above alternatives, the linking of the eastern and western areas of County Galway with a tunnel from the N6 to the R336 was considered.

This alternative does not meet the project objectives to provide a connection to some or all of the national roads leading into the city, namely the N59, N84, N83, and N6/M6 to the east, in order to create an integrated national road network around the city. This would not show an improvement on journey times and journey time reliability which is another project objective. Equally, traffic demand does not justify the very significant cost of such a tunnel and potential environmental impacts. Therefore, a tunnel from east to west was discounted as it is not deliverable and not justified. However, inclusion of shorter sections of tunnel to avoid significant constraints was considered worthy of further study in the solution development process.

As alternatives were available which would have a higher patronage and better meet the project objectives than an east-west tunnel, further examination of this alternative was discounted.

4.7.2 River Corrib Crossing Alternatives

The development of route options for a new crossing of the River Corrib and a road based alternative included designs which avoided existing properties as identified on OS and aerial mapping as much as possible. The N6 Galway City Outer Bypass, 2006 was including in these route options. During the course of the development and appraisal of these alternatives it became evident that more detailed information was available along the route of the 2006 Galway City Outer Bypass than other areas of the scheme study area and hence the development of these alternatives was paused until the necessary detailed environmental studies were undertaken on the entire study area. Detailed ecological surveys, ground investigations at Rahoon and archaeology geophysics at Ballybrit were carried out before the route options were further progressed.

In parallel to this a study was undertaken to identify an on-line option which reutilised as much of the existing road infrastructure including the existing N6 as outlined in **Section 4.7.2.1**.

Once the environmental studies and on-line option development were completed the route option development process recommenced. Based on the initial route options, OS and aerial mapping, transport demand analysis and the results of the ecological surveys, option development zones were developed by the Design Team.

Option development zones were areas within the scheme study area which from a human beings and ecological perspective the more beneficial route options could be developed whilst also bearing in mind the need to connect back to the city to effectively resolve existing transportation issues. It should be noted that all route options developed within these option development zones still had to be assessed by all other environmental specialists, which further reduced the zones available for route option development. Therefore, the situation arose where route options were developed outside of these zones to reduce the impact on other key environmental constraints with the necessary mitigation measures included in the design of the route option.

Plate 4.7 illustrates the available option development zones through the Lough Corrib cSAC at the River Corrib crossing. A number of route options were then refined and developed by the engineering team within the established option development zones commencing from the River Corrib crossing locations in so far as reasonably possible within the confines of engineering standards and all other constraints.

The development of these feasible route options was a two-stage process with the initial routes developed known as Stage 1 Route Options. These route options comprised on-line options which include an upgrade of the existing infrastructure, partial on-line/off-line options and total new construction off-line and are shown below on **Plate 4.8** and a schematic of these options is shown on **Plate 4.9**.

Plate 4.7: Option Development Zones

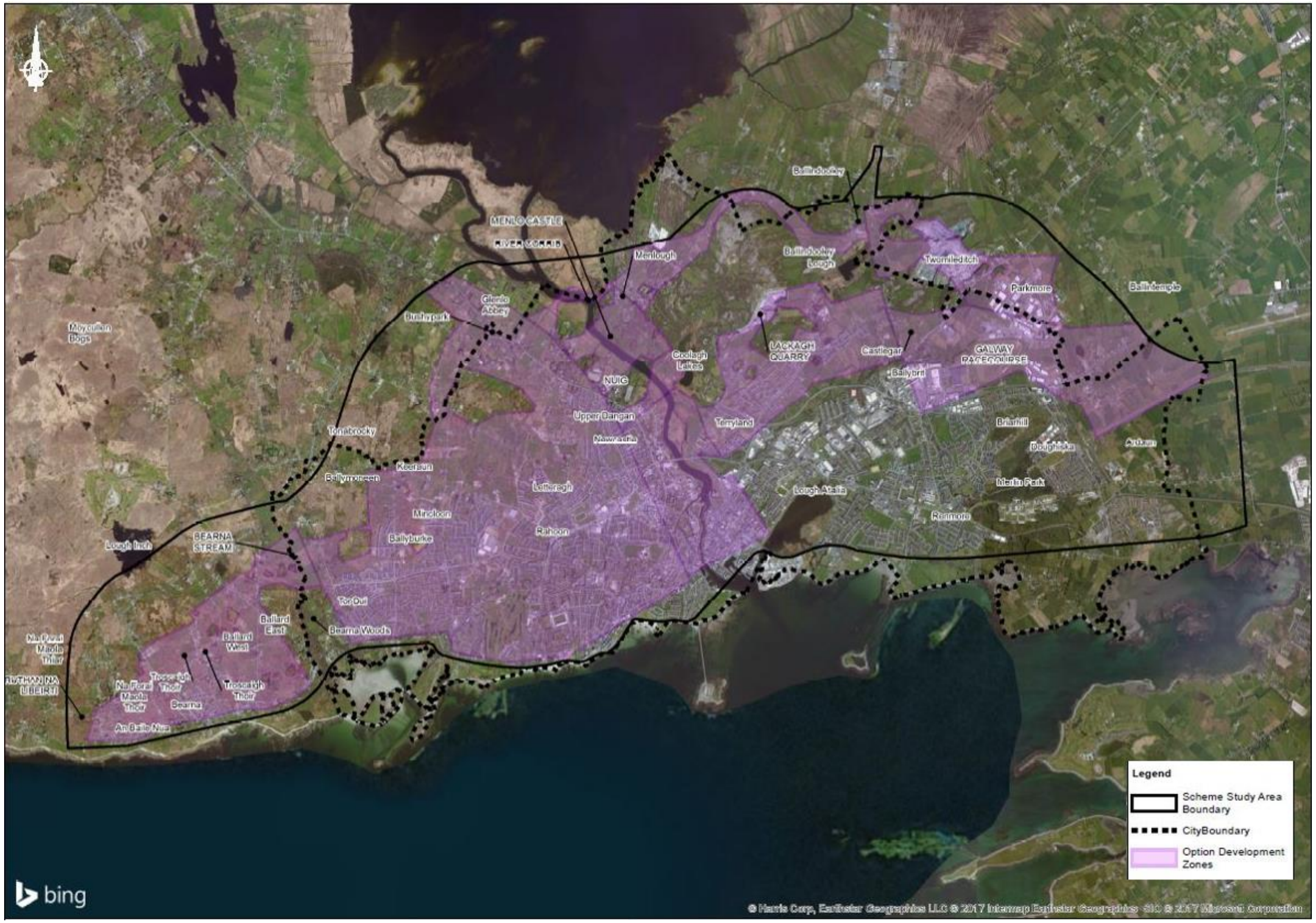


Plate 4.8: Stage 1 Route Options

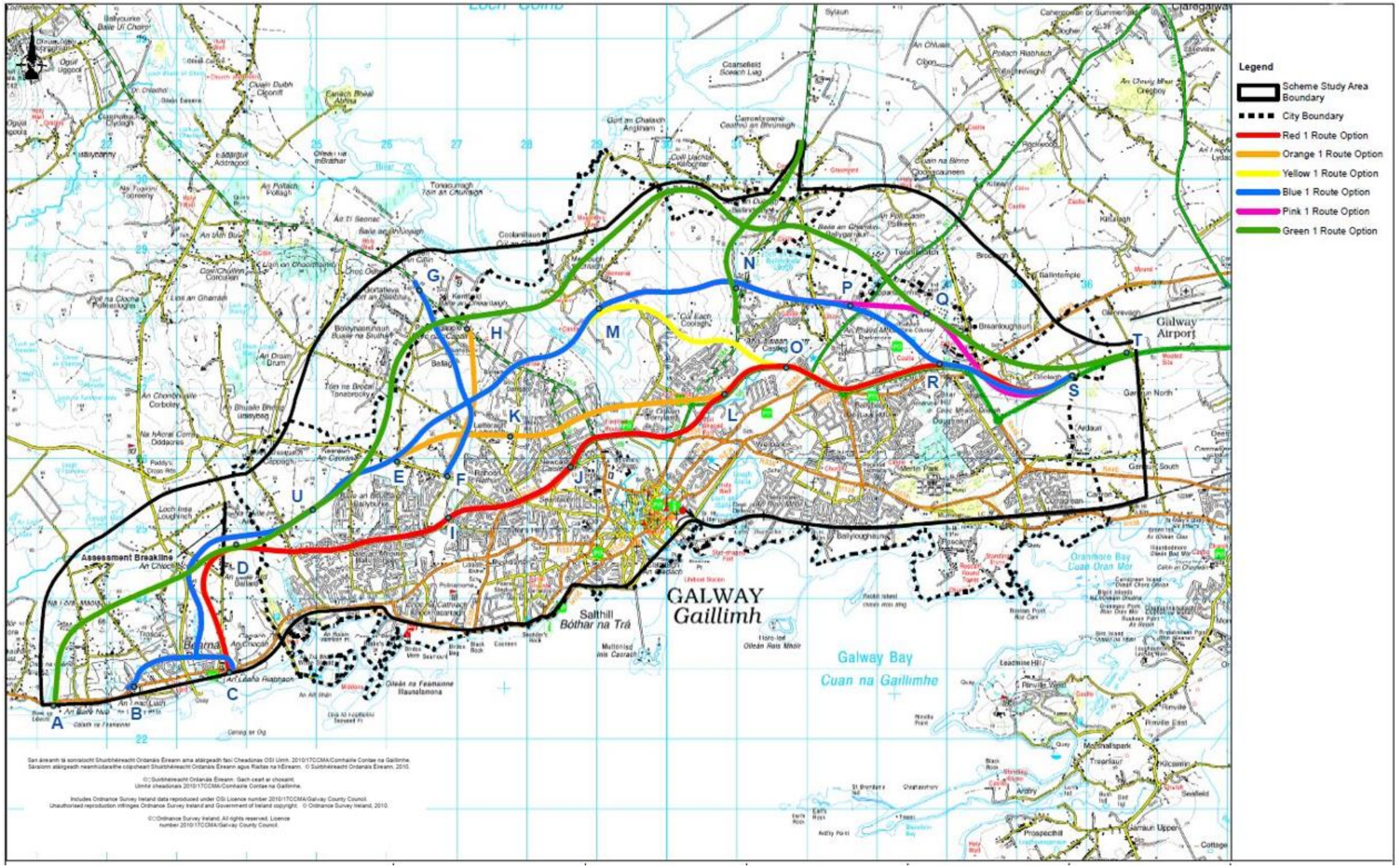
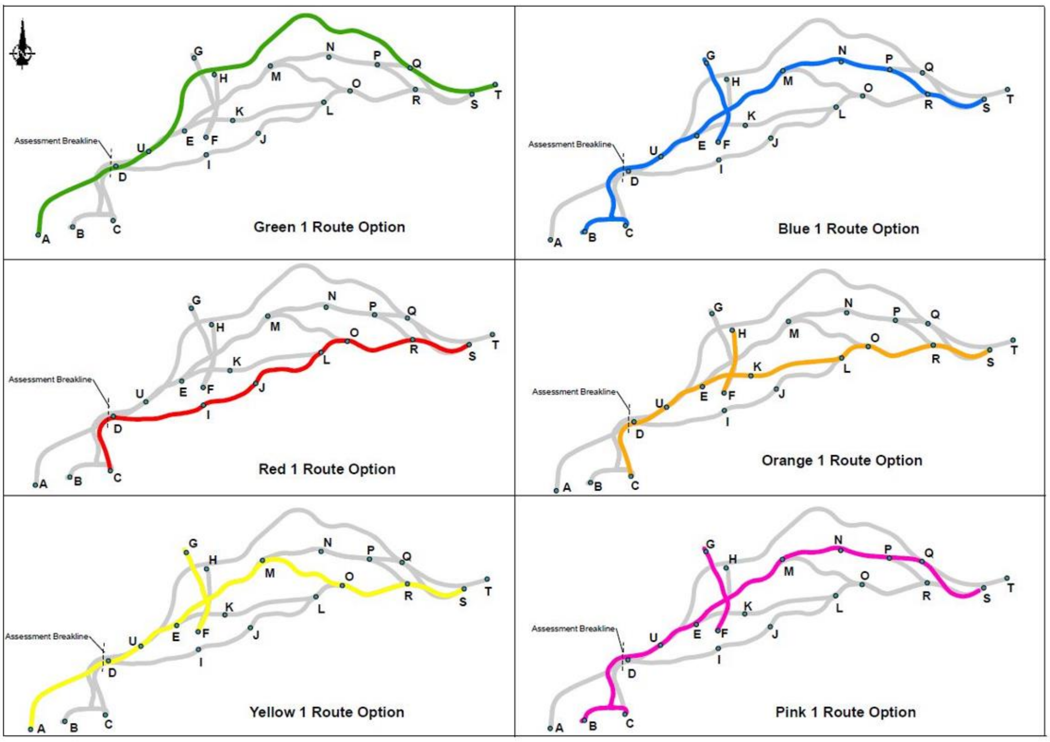


Plate 4.9: Stage 1 Route Options – Schematic



An assessment was completed on these Stage 1 Route Options which included two environmental workshops. These Stage 1 Route Options were presented to the public at Public Consultation No. 2 in January/February 2015. Following public consultation and further studies, the route options were refined and became Stage 2 Route Options. An assessment and appraisal was completed on the Stage 2 Route Options. The Stage 2 Route Options are shown on **Plate 4.10** and a schematic of these options is shown on **Plate 4.11**.

Plate 4.10: Stage 2 Route Options

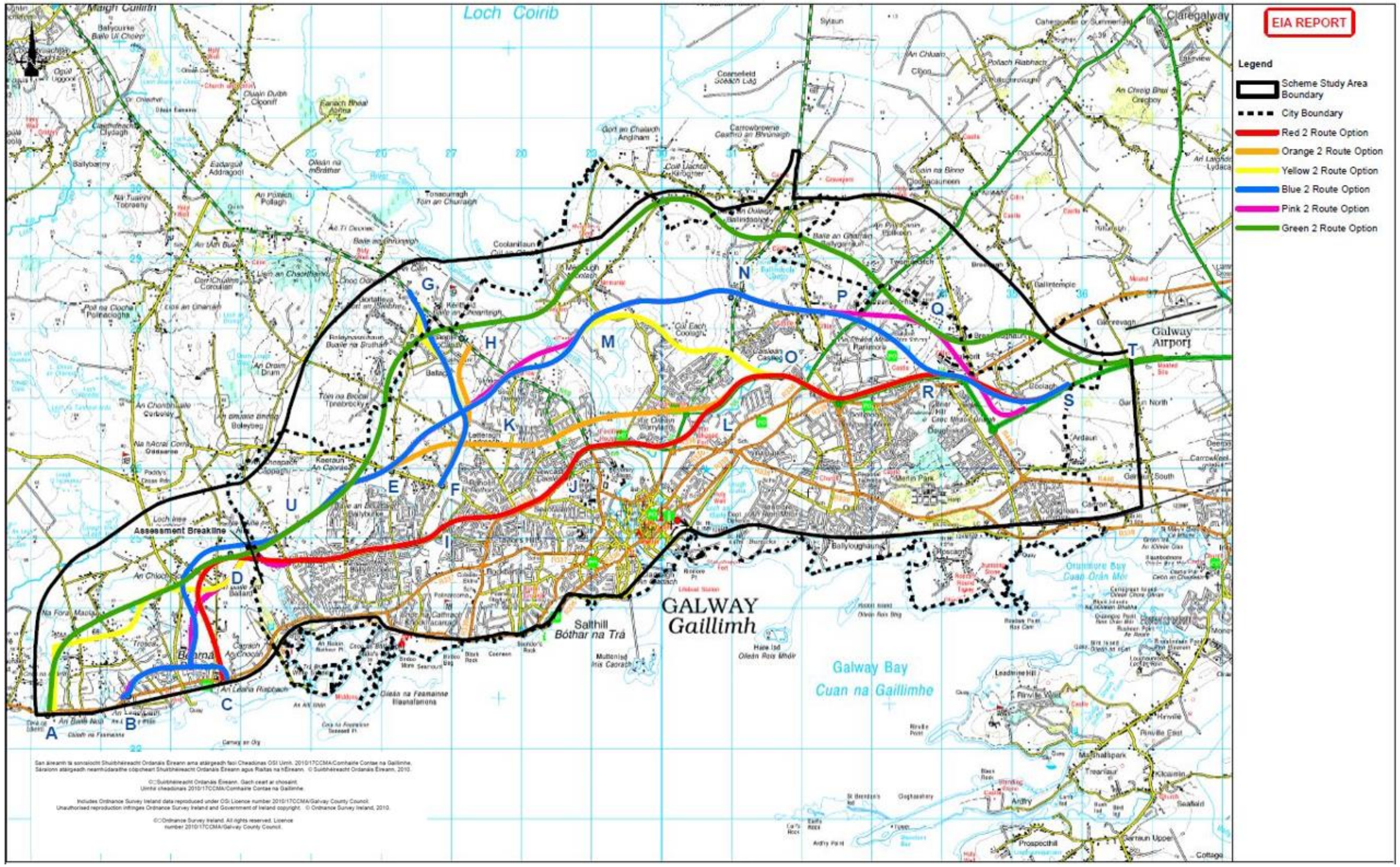
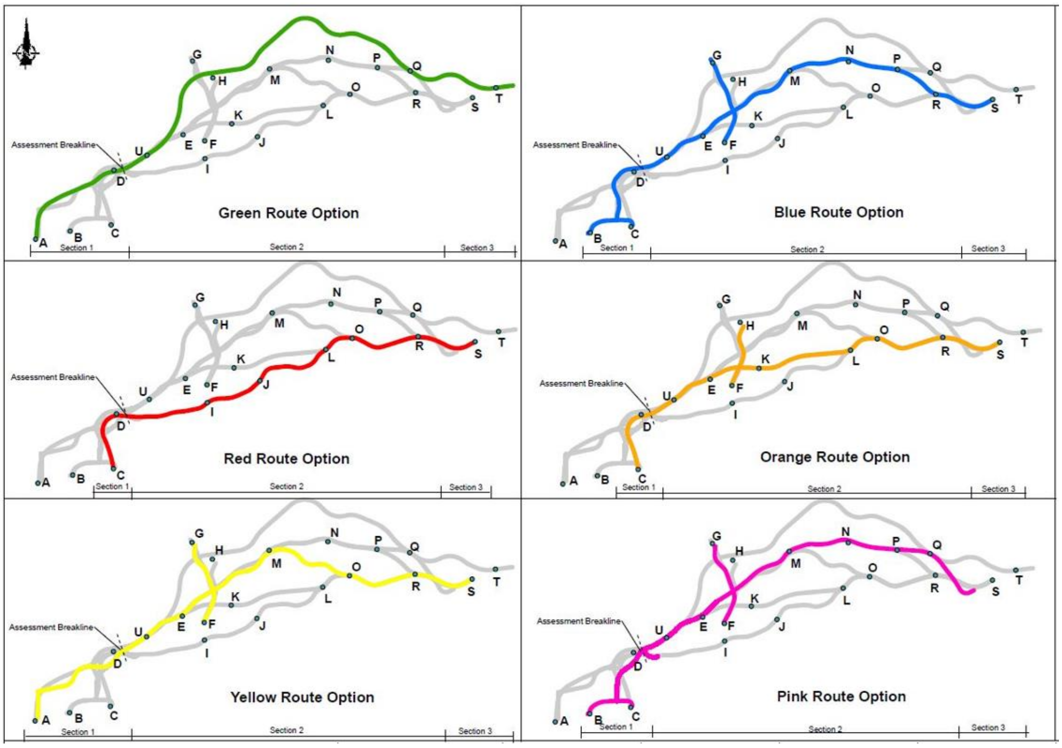


Plate 4.11: Stage 2 Route Options – Schematic



In addition to these route options which are detailed in **Section 4.7.2.1** and **4.7.2.2** below, the 2006 GCOB Route Option (**Section 4.7.2.3** and **Plate 4.12**), a modification of the 2006 GCOB Route Option, the Cyan Route Option (**Section 4.7.2.4** and **Plate 4.13**)) and a switch between two of the off-line route options (**Section 4.7.2.5** and **Plate 4.14**) were also considered as alternatives.

Given the urban environment, density of residential development and the presence of the designated European sites in the scheme study area, a horizontal and vertical alignment for each of the route options was designed. The vertical alignment for some of the route options included sections of tunnels to reduce the impact on key constraints identified.

Plate 4.12: 2006 GCOB Route Option

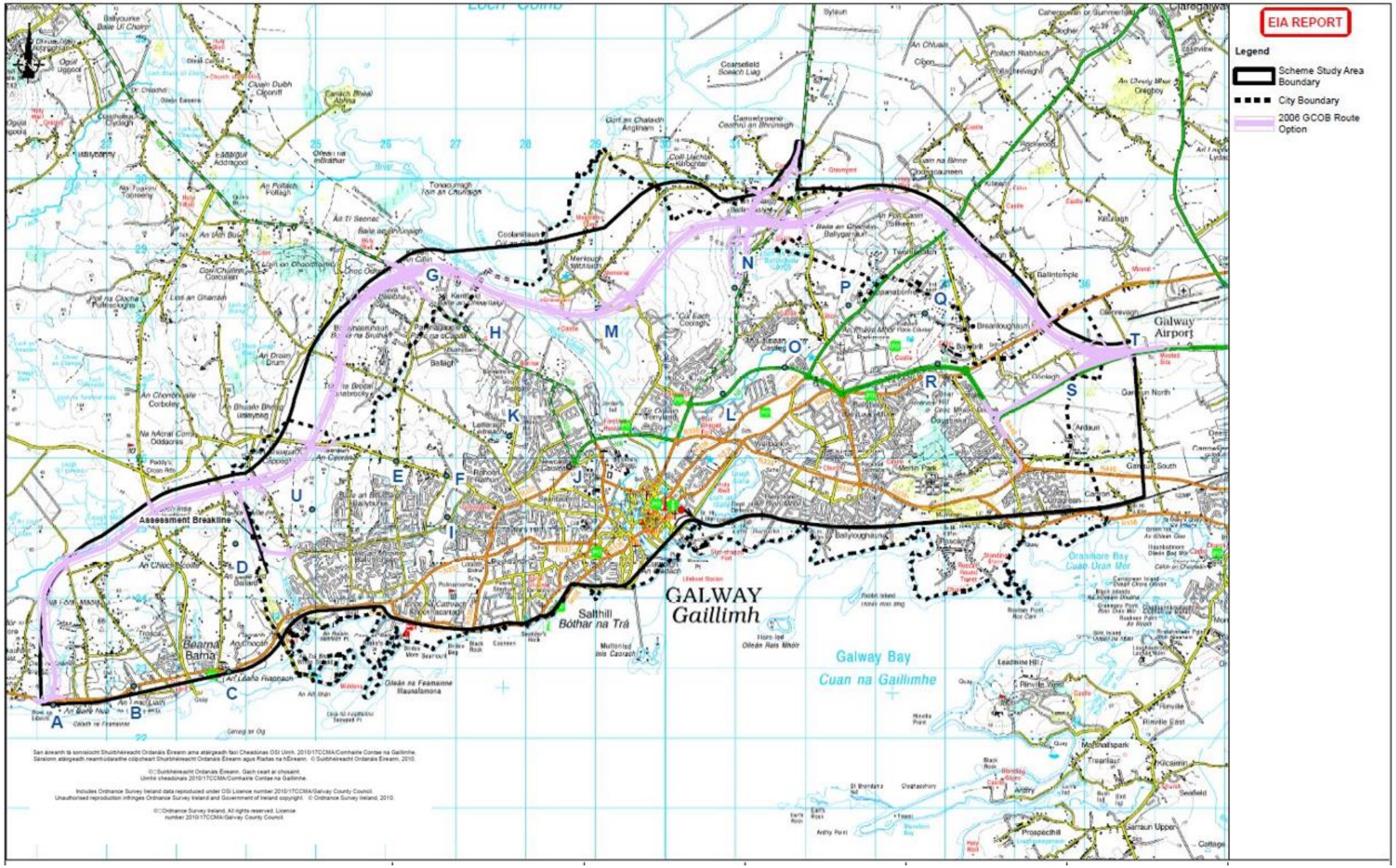


Plate 4.13: Cyan Route Option

Plate 4.14: 'Switch' between the Green and Blue Route Options

4.7.2.1 Stage 1 Route Options

Red Route Option (On-line Route Option)

A full study was undertaken on the upgrading of existing road infrastructure and the development of an on-line route option, where the existing transportation networks and corridors are reused and enhanced where appropriate.

The outcome of this study was a recommendation on which on-line route option to carry forward. This On-line Route Option commenced at a signalised junction at the eastern end of Bearna Village and proceeded north along new road alignments to join the existing Western Distributor Road at a proposed signalised junction at the existing Cappagh Road Roundabout. It followed the existing Western Distributor Road to Bóthar Stiofáin and includes the replacement of all the existing roundabout junctions along Western Distributor Road with signalised junctions.

At the Rahoon area it connected via a tunnel from Bóthar Stiofáin, through a residential area in Rahoon, to the Seamus Quirke Road and was depressed underneath Seamus Quirke Road and Browne Roundabout via a cut and cover tunnel. It included connectivity via a roundabout and slip roads at Gort na Bró. It continued east to the existing Quincentenary Bridge along the existing N6. The existing local road network was to be retained above the proposed mainline over the extents of Seamus Quirke Road. The existing local road network was accommodated by provision of a second bridge crossing over the River Corrib immediately south of the existing Quincentenary Bridge.

To the east of the River Corrib, the On-line Route Option passed behind the existing shopping centre at Terryland and re-joined the existing N6 to the east of the N84 Junction at the Kirwan Roundabout. A split grade separated junction was provided between the existing N6 and the proposed On-line Route Option in this area, with west facing slips to/from the On-line Route Option immediately east of the river crossing and east facing slips to/from the On-line Route Option immediately east of the existing N84 Junction at Kirwan Roundabout.

The On-line Route Option utilised the existing N6 corridor to connect to the M6/N6 on the east side of Galway at Coolagh. It was depressed under the N83 and Ballybane Roads but had full connectivity to both roads via signalised diamond junctions. A full diamond grade separated junction was provided to the south of the existing Briarhill Junction, which was designed to accommodate Parkmore Industrial Park, Ballybrit Business Park, City East Business Park and the Briarhill area of the city.

The On-line Route Option was deemed a feasible option and was carried forward as the Red Route Option for assessment as part of the route selection process.

Orange Route Option

The Orange Route Option commenced at the same point as the Red Route Option to the east of Bearna, and followed the path of the Red Route Option around Ballard. It diverged from the Red Route Option and travelled through Ballyburke, towards Letteragh, where it entered a tunnel. It crossed under the River Corrib in the tunnel and emerged in Terryland, to the east of the existing Kirwan Roundabout. The

Orange Route Option then followed the Red Route Option along the existing N6 with all junctions upgraded to grade-separated junctions.

There was a link road associated with the Orange Route Option which commenced on the N59 at Ballagh and finished at the northern end of Bóthar Stiofáin, connecting to the mainline of the Orange Route Option with a grade separated junction.

Yellow Route Option

The Yellow Route Option commenced at a junction with the R336 to the west of Bearna and travelled north-east, keeping to the north of Bearna and passing through the townlands of An Chloch Scoilte, Na hAille, Ballyburke, Letteragh and Dangan. It crossed the River Corrib to the south of Menlo Castle, then turned south-east and passed through the townlands of Coolagh and Castlegar. It joined the Red Route Option to the west of the junction with the N83 and followed the Red Route Option eastwards along the existing N6, with all junctions upgraded to grade separated junctions.

There was a link road associated with the Yellow Route Option which commenced on the N59 at Gortacleva and finished at the northern end of Bóthar Stiofáin, connecting to the mainline of the Yellow Route Option with a grade separated junction.

Blue Route Option

The Blue Route Option commenced with a junction on the R336 on the western outskirts of Bearna and proceeded along an existing relief road parallel to and north of the R336. The remainder of the Bearna Inner Relief Road, to tie back to the existing R336 in the eastern outskirts of Bearna, was included as part of the Blue Route Option. From the relief road the Blue Route Option travels north-east through the townlands of An Chloch Scoilte, Na hAille, Ballyburke, Letteragh and Dangan before crossing the River Corrib to the south of Menlo Castle. It then continued east towards Lackagh Quarry, entering a tunnel to pass beneath the Annex I habitat within the Lough Corrib cSAC and emerging in the quarry, before passing through the townlands of Castlegar and Ballybrit. The Blue Route Option enters a second tunnel to pass underneath the racecourse at Galway Racecourse, emerging above ground in the vicinity of Briarhill, and followed the Red Route Option to its eastern extremity.

There was a link road associated with the Blue Route Option which commenced on the N59 at Gortacleva and finished at the northern end of Bóthar Stiofáin, connecting to the mainline of the Blue Route Option with a grade separated junction.

Pink Route Option

The Pink Route Option commenced to the west of Bearna at the same point as the Blue Route Option, and followed the same path as the Blue Route Option as far as Castlegar. It then diverged to the north of the racetrack at Galway Racecourse, and entered a tunnel on the eastern side of the N83. This tunnel passed under the racecourse access road. This route option passed to the south-east of Coolagh Village and connected to the existing N6.

There was a link road associated with the Pink Route Option which commenced on the N59 at Gortacleva and finished at the northern end of Bóthar Stiofáin, connecting to the mainline of the Pink Route Option with a grade separated junction.

Green Route Option

The Green Route Option commenced at the same point as the Yellow Route Option to the west of Bearna and travelled north-east, keeping to the north of Bearna and passing through the townlands of An Chloch Scoilte, Na hAille, Keeraun, Tonabrocky and Bushypark before crossing the River Corrib to the north of Menlo Castle. The Green Route Option proceeded north-east through Menlough to Ballindooley and south-east through Cappanabornia, around the back of Galway Racecourse in a tunnel beneath the racecourse access road, where it briefly overlapped with the Pink Route Option. It passed through the northern part of Coolagh Village before terminating at the existing N6 to the east.

4.7.2.2 Stage 2 Route Options

This section details the major amendments and alterations made to the route options between Stage 1 and Stage 2. Each amendment and alteration improved on previous designs and options in order to address concerns raised and issues identified through public consultation. Details of the extensive public consultation undertaken as part of the proposed road development are set out in **Chapter 1, Introduction**. A plan layout and schematic of the Stage 2 Route Options outlined below are shown on **Plates 4.10** and **4.11**.

Red Route Option

1. Further traffic assessment identified capacity issues on the mainline from the N83 to the N6 at Briarhill. This required the addition of a lane in each direction of travel. The additional westbound lane terminates at the diverge ramp of City East Business Park grade separated junction. The additional eastbound lane commences at the merge ramp from the N83 grade separated junction. The lanes terminate prior to joining the existing N6.

Orange Route Option

1. The link road from the N59 at Bushypark Church to Bóthar Stiofán in Knocknacarra was re-aligned to take account of residentially zoned lands. The junction with the N59 remains a signalised junction.
2. Further traffic assessment identified capacity issues on the mainline from the N83 to the N6 at Briarhill. This required the addition of a lane in each direction of travel. The additional westbound lane terminates at the diverge ramp of City East Business Park grade separated junction. The additional eastbound lane commences at the merge ramp from the N83 grade separated junction. The lanes terminate prior to joining the existing N6.

Yellow Route Option

1. The route option corridor from the R336 to Knocknacarra was modified in order to minimise impacts to residential properties and communities in the Bearna area.

2. The link road from the N59 at Glenlo Abbey to Bóthar Stiofán in Knocknacarra was re-aligned in order to take account of residentially zoned lands and to minimise impacts to residential properties and communities. The realignment also necessitated provision of a signalised junction connection at the N59.
3. Further traffic assessment identified capacity issues on the mainline from the N83 to the N6 at Briarhill. This required the addition of a lane in each direction of travel. The additional westbound lane terminates at the diverge ramp of City East Business Park grade separated junction. The additional eastbound lane commences at the merge ramp from the N83 grade separated junction. The lanes terminate prior to joining the existing N6.

Blue Route Option

1. The layout of the Bearna Inner Relief road was modified to minimise impacts to residential properties.
2. The junction layouts on the N84 and N83 were re-examined. Further traffic assessment and design work was undertaken in order to minimise the impacts to residential properties and communities in the Castlegar area from the N84 to the N83.

Pink Route Option

1. The layout of the Bearna Inner Relief road was modified on its western extents to match the previous Part 8 planning application for this section of the route option. At its eastern extents the layout was modified to minimise impacts to residential properties.
2. The route corridor from Bearna Village to Knocknacarra was modified in order to minimise impacts to residential properties and communities in the Bearna area.
3. The link road from the N59 at Glenlo Abbey to Bóthar Stiofán in Knocknacarra was re-aligned in order to take account of residentially zoned lands and to minimise impacts to residential properties and communities in the Bushypark area. The realignment also necessitated provision of a signalised junction connection at the N59.
4. The N59 grade separated junction was re-examined and further design work undertaken in order to minimise the impacts to residential properties and communities in the Circular Road area.
5. The mainline alignment was modified in the vicinity of the National University of Ireland, Galway (NUIG) and St. James' National School, Bushypark in order to minimise impacts to the recreational, commercial business and educational facilities in the area.
6. The junction layouts on the N84 and N83 were re-examined. Further traffic assessment and design work was undertaken in order to minimise the impacts to residential properties and communities in the Castlegar area from the N84 to the N83.
7. The junction layout at Coolagh/Briarhill was re-examined and further design work undertaken in order to minimise the impacts to residential properties and communities in the Coolagh area.

Green Route Option

1. The route corridor from the N83 to the N6 was modified in order to minimise impacts to residential properties and communities in the Coolagh/Briarhill area.
2. The split junction layout at Coolagh/Briarhill was re-examined and further design work undertaken in order to minimise the impacts to residential properties, educational facilities and communities in the Coolagh area.

4.7.2.3 N6 Galway City Outer Bypass (2006)

As noted in **Chapter 1, Introduction**, the eastern section of the N6 Galway City Outer Bypass (GCOB 2006) from the existing N6 to the N59 was approved by An Bord Pleanála (ABP) in 2008. At that point in time, the N6 GCOB 2006 scheme was assessed on the premise that the loss of a relatively small area of Priority Annex I habitat would not adversely affect the integrity of the Lough Corrib cSAC, and the scheme was taken forward on the basis of Article 6(3) of the Habitats Directive.

The N6 GCOB 2006 was one of the first road based alternatives considered as it was previously progressed through planning and there was also significant knowledge and detail available on this route option (refer to **Plate 4.12**).

Upon completion of the detailed ecological surveys and the definition of the option development zones, it was possible to comparatively assess and rank other road based alternatives with the N6 GCOB 2006 Route Option.

4.7.2.4 Cyan Route Option

The Cyan Route Option is a reconfiguration of the 2006 GCOB to address the issues raised by ABP in its refusal of the western section of the 2006 GCOB. This route option reflects the 2006 GCOB route option to the east of the River Corrib (i.e. approved by ABP in 2008) but with the addition of a grade separated junction on N83 at the crossing point. It follows an alternative route to 2006 GCOB to the west of the River Corrib (i.e. refused by ABP in 2008) in order to address the issues raised by ABP (refer to **Plate 4.13**).

4.7.2.5 Green – Blue Switch Route Option

This ‘Green - Blue Switch Route Option’ shown on **Plate 4.14**, provided an alternative route option which included the Stage 2 Green Route Option from the R336 to and including, the River Corrib crossing point. It then connected with the Stage 2 Blue Route Option before entering into Lackagh Quarry and followed the path of the Stage 2 Blue Route Option to the N6.

4.7.3 Appraisal of River Corrib Crossing Alternatives

4.7.3.1 Overview of environmental considerations

An appraisal of all of the following route options for the road based alternatives outline above was completed:

- Stage 2 Red Route Option
- Stage 2 Orange Route Option
- Stage 2 Yellow Route Option
- Stage 2 Blue Route Option
- Stage 2 Pink Route Option
- Stage 2 Green Route Option
- N6 GCOB 2006
- Cyan Route Option
- Green to Blue Switch Route Option

The routes were split into three sections for the purposes of the appraisal. The Galway City boundary line represents the assessment break line between Section 1 and 2 as this is the point at which route options merge and it becomes possible to switch between route options. The Bearna section, i.e. R336 to the Galway City boundary (Section 1) was assessed independently to ensure that the optimum solution for Bearna is obtained. An additional break down at the existing N6 tie-in at Briarhill, Coolagh was incorporated in order to compare the junction layouts at the existing N6 tie-in and is referred to as Section 3.

Table 4.2 below gives a summary of the potential environmental impacts on each of the route options.

Table 4.2: Key Potential Significant Environmental Impacts

Route Option	Significant Environmental Impacts
Stage 2 Red Route Option	• Material Assets Non-Agriculture – see **Table 4.3** (Property Acquisition Assessment) below • Noise and Vibration/Air and Climate – Constructability • Human Beings – Community Impacts and Constructability • Landscape & Visual – Constructability • Archaeology, Architecture and Cultural Heritage – Rahoon archaeological site • Planning – Conflict with vision for the city development and does not allow the city to implement other objectives • Engineering – Constructability

Route Option	Significant Environmental Impacts
	• Ecology – Unlikely to have adverse effects on the integrity of the Lough Corrib cSAC
Stage 2 Orange Route Option	• Material Assets Non-Agriculture – see **Table 4.3** (Property Acquisition Assessment) below • Ecology – Unlikely to have adverse effects on the integrity of the Lough Corrib cSAC • Engineering and soils and geology – Constructability through limestone and granite • Potential construction waste due to the construction of the proposed tunnel • Potential hydrogeological impacts and in turn indirect ecological impacts
Stage 2 Yellow Route Option	• Material Assets Non-Agriculture – see **Table 4.3** (Property Acquisition Assessment) below • Human Beings – Community Impacts • Ecology – Likely to have adverse effects on the integrity of the Lough Corrib cSAC
Stage 2 Blue Route Option	• Material Assets Non-Agriculture – see **Table 4.3** below and potential impacts on NUIG Sporting Campus, Galway Racecourse and Dangan Nurseries • Ecology – Unlikely to have adverse effects on the integrity of the Lough Corrib cSAC
Stage 2 Pink Route Option	• Material Assets Non-Agriculture – see **Table 4.3** (Property Acquisition Assessment) below and potential impacts on NUIG Sporting Campus, Galway Racecourse and Dangan Nurseries • Ecology – Unlikely to have adverse effects on the integrity of the Lough Corrib cSAC
Stage 2 Green Route Option	• Material Assets Non-Agriculture – see **Table 4.3** (Property Acquisition Assessment) below • Human Beings– Menlough, Killoughter Ballindooley and Bushypark communities • Landscape and Visual – Menlo Castle, Menlough, Killoughter and Ballindooley communities • Archaeology, Architecture and Cultural Heritage – Menlo Castle and Menlough Village • Ecology – Likely to have adverse effects on the integrity of the Lough Corrib cSAC

Route Option	Significant Environmental Impacts
N6 GCOB 2006	• Material Assets Non-Agriculture – see **Table 4.3** (Property Acquisition Assessment) below • Landscape and Visual – Menlo Castle • Archaeology, Architecture and Cultural Heritage – Menlo Castle • Human Beings – Menlo Castle in terms of the amenity value • Ecology - adverse impact on the site integrity of the Lough Corrib cSAC per the European Court decision, potential to impact on Lough Inch River which is known to contain Freshwater pearl mussels downstream, significant impact on the Moycullen Bog Complex NHA from a hydrogeological and hydrological perspective both at Tonabrocky and in the vicinity of Lough Inch
Cyan Route Option	• Material Assets Non-Agriculture – see **Table 4.3** (Property Acquisition Assessment) below • Landscape and Visual – Menlo Castle • Archaeology, Architecture and Cultural Heritage – Menlo Castle • Human Beings – Menlo Castle in terms of the amenity value • Ecology - adverse impact on the site integrity of the Lough Corrib cSAC per the European Court decision
Green to Blue Switch Route Option	• Material Assets Non-Agriculture – see T**able 4.3** (Property Acquisition Assessment) below • Landscape and Visual – Menlo Castle • Archaeology, Architecture and Cultural Heritage – Menlo Castle • Human Beings – Menlo Castle in terms of the amenity value • Ecology – potential impacts due to River Corrib Bridge

A comparative assessment of the property acquisition on each of the above options was also undertaken and is outlined in **Table 4.3** below, with the number split into the relevant three sections.

Table 4.3: Property Demolition Assessment – Route selection phase

Route Option	Residential Demolitions			Commercial Demolitions			Total
	Section 1	Section 2	Section 3	Section 1	Section 2	Section 3	
Red	14	73	7	0	19	0	113
Orange	14	32	7	0	9	0	62
Yellow	**2**	97*	7	**0**	11	0	117
Blue	6	42	6	0	6	0	60
Pink	3	**42**	**1**	0	**6**	**0**	52
Green	17	54	5	0	10	0	86
2006 GCOB	*Note sectional division not equivalent on old GCOB, and there are alternatives which better meet the project objectives than the old GCOB.*						10
Cyan**	16	25	0	0	0	0	41
Green – Blue Switch Route Option	17	62	6	0	2	0	87
Emerging Preferred Route Corridor	**2**	**42**	**1**	**0**	**6**	**0**	**51**
N6 GCRR	**9**	**43**	**2**	**0**	**7**	**0**	**61**

*An apartment block accounts for 37 residential acquisitions

** Cyan Route Option is a reconfiguration of the 2006 GCOB to achieve the current scheme objectives

4.7.3.2 N6 GCOB 2006 Appraisal

Full analysis showed that there are other alternatives which better meet the project objectives in terms of capturing existing travel demand than the N6 GCOB 2006 Route Option and which do not impact on the integrity of the Lough Corrib cSAC. When compared with the option development zones, i.e. areas within which from a human being and ecological perspective options could be developed, it was also evident that the N6 GCOB 2006 Route Option was located outside these zones over the majority of its length.

It should be noted that the boundary of the Lough Corrib cSAC was extended post lodgement of the N6 GCOB 2006 planning application with ABP, resulting in a greater length of this N6 GCOB 2006 Route Option crossing through the Lough Corrib cSAC and therefore having a greater impact on its integrity than originally anticipated in the N6 GCOB 2006 Environmental Impact Statement.

While the N6 GCOB 2006 had the least number of property acquisitions, as noted previously the western section did not receive planning permission from ABP under the earlier application due to potential environmental impacts in the area of Tonabrocky Bog pNHA. Therefore, the property acquisitions are not a true reflection of the likely property impacts of a new scheme that would meet the present project objectives. Further, the N6 GCOB 2006 would not deliver the optimum intermodal transport solution as extensive traffic modelling shows that it would not deliver relief to congestion to the same level as other road based alternatives.

Further still, in terms of the N6 GCOB 2006:

- It does not provide connection with the N83 Tuam Road, a national road, thereby providing a lesser level of connectivity
- It does not provide any connection to the key employment centres at Parkmore and Ballybrit and, therefore, minimal relief to the existing congestion at the eastern city extents
- It has an adverse impact on the site integrity of the Lough Corrib cSAC per the European Court decision
- It has potential to impact on Lough Inch River which is known to contain Freshwater pearl mussels downstream
- It has a significant impact on the Moycullen Bog Complex NHA from a hydrogeological and hydrological perspective both at Tonabrocky and in the vicinity of Lough Inch
- It has a profound impact on the curtilage of Menlo Castle from a cultural heritage perspective and on the amenity value from Human Beings perspective
- It has less impacts on communities and amenities with an overall improvement in the level of severance experienced, but at the expense of longer journey times and less relevant journey possibilities between east and west

and so it was not advanced further.

4.7.3.3 Cyan Route Option Appraisal

As can be seen from **Table 4.3**, the Cyan Route Option has more property acquisitions than the N6 GCOB 2006. This is as a result of the alternative route on the west to minimise the environmental impacts identified in the earlier decision of ABP, plus the addition of the N83 Tuam Road Junction. The Cyan Route Option would not deliver the optimum intermodal transport solution as extensive traffic modelling shows that it would not deliver relief to congestion to the same level as other road based alternatives.

Further still, in terms of the Cyan Route Option:

- It does not provide a direct connection to the key employment centres at Parkmore and Ballybrit and, therefore, minimal relief to the existing congestion at the eastern city extents
- It has an adverse impact on the site integrity of the Lough Corrib cSAC per the European Court decision
- It has a profound impact on the curtilage of Menlo Castle from a cultural heritage perspective and on the amenity value from Human Beings perspective

and so it was not advanced further.

4.7.3.4 Green – Blue Switch Route Option Appraisal

This route option provided an alternative crossing of the River Corrib, connecting the Green Route Option west of the river with the Blue Route Option east of the river with the benefit of the avoidance of impacts to NUIG Sporting Campus and reduction of direct impacts on the Dangan area west of the River Corrib, and the avoidance of Menlough Village to the east of the River Corrib.

An assessment of this route option showed however that:

- the connection between the Stage 2 Green and Blue Route Options at Menlough had a greater impact on Menlo Castle from an architectural and cultural heritage (profound impact) and landscape and visual and human being amenity value perspective than either the Green or Blue Route Options considered alone
- the direct impact on residential properties for this alternative route option is also greater with the highest number of residential acquisitions when compared to that of the Blue or Green Route Options considered alone
- this route option has potentially an impact on flood risk in the vicinity of the River Corrib and its floodplains
- due to the presence of soft and peat soils, the location of the River Corrib Bridge crossing presents a major negative in terms of soils and geology
- this route option would result in significant impacts to a qualifying interest of the Lough Corrib cSAC habitat (Alkaline fen) on the west bank of the River Corrib in Lough Corrib cSAC and would adversely affect the integrity of the Lough Corrib cSAC
- this route option is also potentially the most damaging with respect to the local Lesser horseshoe bat population given its proximity to Menlo Castle and the core foraging area

and so it was not advanced further.

4.7.3.5 Remaining Route Options Appraisal

Each of the remaining route options were ranked with respect to their impacts for each environmental discipline as follows: Preferred (P), Intermediate (I), and Least Preferred (LP). These terms are used to comparatively assess route options in either Section 1, Section 2 or Section 3 and should not be interpreted to compare the significance of impacts between these sections. For example, by virtue of the fact that route options in Section 2 cross a European site whereas in Section 1 they do not, the route option(s) assigned a ranking of LP in Section 2 for ecology are likely to have a much greater impact on the ecological environment than the route option(s) assigned a ranking of LP in Section 1.

The overall ranking for each route option in terms of the environment took into consideration the overall number of preferred, intermediate and least preferred rankings. During the course of the assessment process *Human Beings, Ecology, Landscape and Visual, and Material Assets – Non Agricultural* were identified as disciplines which had key significant constraints. For example, impacts on human beings such as communities and residential property acquisitions and impacts on ecology such as on European sites were all key significant constraints which required further consideration during the decision making process. Therefore, these disciplines are shown in italics in the summary tables and are referred to as "key environmental disciplines" below.

Section 1

The Yellow Route Option is the preferred route option overall for Section 1. It has five preferred, five intermediate and two least preferred rankings. Of the five preferred rankings, three are for key environmental disciplines. Of the two least preferred rankings, one of these was for a key environmental discipline (ecology), however as noted above, route options in Section 2 cross a European site whereas in Section 1 they do not, therefore ecological constraints in Section 1 are not as significant as those in Section 2. The Yellow Route Option has the lowest number of least preferred rankings overall.

The Pink Route Option has been assigned an Intermediate ranking overall for Section 1. The Pink Route Option has one preferred, seven intermediate and four least preferred rankings. The Pink Route Option has no key environmental discipline which has a preferred or least preferred ranking.

The Blue Route Option has also been assigned an Intermediate ranking overall for Section 1. The Blue Route Option has one preferred, six intermediate and five least preferred rankings. Of the five least preferred rankings, one of these was for a key environmental discipline (landscape and visual). This route option has no preferred rankings for a key environmental discipline.

The Red, Orange and Green Route Options have all been assigned a Least Preferred ranking overall for Section 1.

The Red Route Option has six preferred, two intermediate and four least preferred rankings. Of the four least preferred rankings, three are for key environmental disciplines. The Orange Route Option has seven preferred, one intermediate and four least preferred rankings. Of the four least preferred rankings, three are for key environmental disciplines. The Green Route Option has one preferred, five intermediate and six least preferred. Of the six least preferred, three are for key environmental disciplines

In conclusion, the Yellow Route Option is the preferred route option for Section 1.

Section 2

The Orange and Pink Route Options are both the preferred route options overall for Section 2. The Blue Route Option has been assigned an intermediate ranking overall for Section 2. The Red, Yellow and Green Route Options have all been assigned a least preferred ranking overall for Section 2. The overall rankings are discussed further below. In addition, given that the Lough Corrib cSAC is one of the more significant constraints in Section 2, ecology ranking is also discussed in more detail below.

<u>Orange Route Option</u>

The Orange Route Option has been assigned a preferred ranking for Section 2. The Orange Route Option has the greatest number of preferred rankings (six), two intermediate and four least preferred. Of the four least preferred rankings, none are for a key environmental discipline. The Orange Route Option includes a 3.5km tunnel and therefore many of the environmental constraints are not directly impacted, therefore it has been assigned a preferred ranking overall.

The Orange Route Option is the preferred route option from an ecological perspective as it avoids direct impacts on the Lough Corrib cSAC and as a significant length of this route option is either predominantly online or underground, its impact is reduced on many of the other ecological receptors identified within the scheme study area.

It should be noted that whilst the tunnel avoids direct impacts on the environmental constraints a 3.5km tunnel has the potential to indirectly impact on groundwater and groundwater dependant habitats within the Lough Corrib cSAC and Galway Bay Complex cSAC.

<u>Pink Route Option</u>

The Pink Route Option has also been assigned a preferred ranking for Section 2. The Pink Route Option has the second highest number of preferred rankings (four), six intermediate rankings and two least preferred. Of the two least preferred rankings, none are for a key environmental discipline. Of the preferred rankings, one is for a key environmental discipline (Material Assets Non-Agriculture). The Pink Route Option has the lowest number of least preferred rankings taking all environmental disciplines into consideration.

The Pink Route Option is ranked as intermediate from an ecological perspective in Section 2.

Both the Pink and Blue Route Options are similar from an ecological perspective as although they avoid any direct impacts to Annex I habitats within the boundary of the Lough Corrib cSAC, they will result in some degree of habitat loss within the designated site. Pink Route Option has a larger footprint than the Blue Route

Option within the Lough Corrib cSAC and a greater impact than the Blue Route Option on Annex I habitat overall in this section.

Blue Route Option

The Blue Route Option has been assigned an intermediate ranking overall for Section 2. It has one preferred ranking, seven intermediate, and four least preferred. Of the four least preferred rankings, one is for a key environmental discipline (landscape and visual). This route option has no preferred rankings for a key discipline.

The Blue Route Option is ranked as intermediate from an ecological perspective in Section 2. Blue is slightly more preferred than the Pink Route Option from an ecological perspective due to its smaller footprint within the Lough Corrib cSAC and lesser impact than the Pink Route Option on Annex I habitat overall in this section.

However, other negative impacts were experienced by other environmental disciplines for the Blue Route Option, for example the Material Assets Non-Agricultural impacts on NUIG Sporting Campus and other commercial properties in the vicinity and Landscape and Visual impacts.

Red Route Option

The Red Route Option has been assigned a least preferred ranking overall for Section 2. The Red Route Option has three preferred rankings, one intermediate and eight least preferred. Of the eight least preferred, three are key environmental disciplines. This route option has one preferred ranking for a key discipline (Ecology).

The Red Route Option is ranked as preferred from an ecological perspective in Section 2. The Red Route Option is one of the route options with the lowest overall impact on the Lough Corrib cSAC, the lowest impact on Annex I habitats of all the route options and, by virtue of being predominantly on-line, is likely to have the least impact on most other ecological receptors.

Although the Red Route Option is preferred for ecology, it has been assigned a Least Preferred ranking overall because, potential significant/profound impacts have been identified on the Red Route Option for landscape and visual, archaeology and heritage, material assets non-agriculture and human beings. Other negative impacts are also experienced for other environmental disciplines such as soils and geology, air and climate, planning and noise and vibration. The cumulative impact of all of the other significant/profound negative impacts experienced by the other environmental disciplines means that this route option has been assigned a ranking as least preferred overall.

Yellow Route Option

The Yellow Route Option has been assigned a least preferred ranking overall for Section 2. The Yellow Route Option has one preferred, four intermediate, one intermediate/least preferred and six least preferred. Of the six least preferred rankings, four are for key environmental disciplines.

The Yellow Route Option is ranked as least preferred from an ecological perspective in Section 2 because it is the route option with the greatest potential for impacts to qualifying interests (QI) Annex I habitat within the Lough Corrib cSAC. The Yellow Route Option was found to likely result in adverse effects on the integrity of Lough Corrib cSAC.

Green Route Option

The Green Route Option has been assigned a least preferred ranking overall for Section 2. The Green Route Option has one preferred, four intermediate and seven least preferred. Of the seven least preferred rankings, three are key environmental disciplines.

The Green Route Option is ranked as least preferred from an ecological perspective in Section 2 as it is likely to result in indirect impacts to QI Annex I habitat within the Lough Corrib cSAC but less than that associated with the Yellow Route Option. Green Route Option was found to likely result in adverse effects on the integrity of Lough Corrib cSAC.

In conclusion, the Orange and Pink Route Options are both Preferred for the Environmental Appraisal for Section 2. The Blue Route Option is ranked as intermediate whilst Red, Yellow and Green Route Options are ranked as least preferred for Section 2.

Section 3

All route options have a similar number of preferred, intermediate and least preferred rankings however the Pink Route Option is the preferred for Section 3. It has five preferred, two intermediate and five least preferred rankings. Of the five preferred rankings, two are for key environmental disciplines (landscape and visual and material assets non-agriculture). Of the five least preferred rankings, one is for a key environmental discipline (ecology), however ecological impacts in Section 3 are not on a European site. All other route options are ranked intermediate as they are all similar in the number of preferred, intermediate and least preferred rankings.

In conclusion, the Pink Route Option is the preferred option for Section 3.

4.7.3.6 Conclusion of appraisal

An overall summary of the rankings for the engineering, environmental and economic appraisals for each of the alternatives considered is presented in **Table 4.4** below, including those which were discounted as they were unfeasible or did not meet the project objectives as outlined in **Sections 4.4**, **4.5**, **4.6** and **4.7.1** for the purposes of comparison only.

The rankings for the Red, Orange, Yellow, Blue, Pink and Green Route Options represent those for Section 2 of those route options, i.e. the length from the city boundary at Bearna to the tie-in with the existing N6 at Coolagh as this section is most comparable to all other alternatives. **Tables 4.5** and **4.6** below present the appraisals for Section 1 and Section 3 of these route options separately.

During the course of the assessment process *Human Beings, Ecology, Landscape and Visual and Material Assets Non-Agriculture* were identified as disciplines which had key significant constraints. For example, impacts on human beings such as communities and residential property acquisitions and impacts on ecology such as on European designated sites were all key significant constraints which required further consideration during the decision making process. Therefore, these disciplines are shown in italics in the tables below.

Table 4.4: Appraisal of Alternatives Matrix - Overall

Alternatives	**Do-Nothing**	**Do-Minimum**	**Public Transport Only**	**Lough Corrib Route Option**	**Coastal Route Option**	**Tunnel Over Project Extents**	**2006 Route Option**	**Cyan Route Option**	**Green-Blue Switch Route Option**	**Red Route Option**	**Orange Route Option**	**Yellow Route Option**	**Blue Route Option**	**Pink Route Option**	**Green Route Option**
Engineering															
Length	Do-Nothing was discounted and not appraised as it is not a real alternative given that Galway City and County Councils are progressing other projects	I	Public Transport Only does not meet the project objectives when implemented in isolation and was not appraised in isolation. It was however retained as part of the overall transport solution	LP	I	I	LP	LP	LP	I	**P**	I	I	I	LP
Integration with transport network		LP		LP	LP	LP	LP	I	I	I	LP	LP	I	I	**P**
Constructability		I		LP	LP	LP	**P**	**P**	**P**	LP	LP	I	**P**	**P**	**P**
Traffic Relief		LP		LP	LP	LP	I	I	I	P	I	I	I	I	LP
Environmental															
Ecology		**P**		LP	LP	I	LP	LP	LP	**P**	**P**	LP	I	I	LP
Soils & Geology		**P**		LP	I	LP	I	I	I	LP	LP	I	I	I	**P**
Hydrogeology		**P**		LP	I	LP	LP	I	LP	**P**	I	I	LP	LP	I
Hydrology		**P**		LP	LP	I	LP	I	I	I	**P**	I/LP	I	I	I
Landscape & Visual		**P**		LP	LP	**P**	I	I	LP	LP	**P**	LP	LP	I	LP

Alternatives	**Do-Nothing**	**Do-Minimum**	**Public Transport Only**	**Lough Corrib Route Option**	**Coastal Route Option**	**Tunnel Over Project Extents**	**2006 Route Option**	**Cyan Route Option**	**Green-Blue Switch Route Option**	**Red Route Option**	**Orange Route Option**	**Yellow Route Option**	**Blue Route Option**	**Pink Route Option**	**Green Route Option**
Engineering															
Archaeology & Heritage		**P**		I	I	**P**	LP	LP	LP	LP	**P**	I	I	I	LP
Material Assets - Agriculture		**P**		I	I	**P**	LP	LP	LP	**P**	I	I	LP	LP	LP
Material Assets Non-Agriculture		**P**		I	I	**P**	**P**	**P**	I	LP	**P**	LP	I	**P**	I
Air & Climate		I		I	I	I	I	I	I	LP	LP	**P**	**P**	**P**	I
Noise & Vibration		I		I	I	I	**P**	I	LP	LP	LP	LP	I	**P**	LP
Human Beings		I		I	I	I	I	I	I	LP	**P**	LP	I	I	LP
Planning		I		I	I	I	LP	LP	LP	LP	LP	LP	LP	**P**	LP
Economy															
Cost Benefits		LP		LP	LP	LP	**P**	**P**	**P**	I	LP	**P**	**P**	**P**	**P**
Overall															
Engineering		LP		LP	LP	LP	I	I	I	LP	LP	I	I	**P**	**P**
Environmental		**P**		LP	LP	LP	LP	LP	LP	LP	**P**	LP	I	**P**	LP
Economy		LP		LP	LP	LP	**P**	**P**	**P**	I	LP	P	P	P	P

Note: **P (bold & underlined) = Preferred**, I = Intermediate, LP = Least Preferred; the alternatives which were discounted as they were unfeasible or did not meet the project objectives as outlined in **Sections 4.4, 4.5, 4.6** and **4.7.1** are included for the purposes of comparison only

Table 4.5: Appraisal of Alternatives Matrix – Section 1

Alternatives	Red Route Option	Orange Route Option	Yellow Route Option	Blue Route Option	Pink Route Option	Green Route Option
Engineering						
Length	<u>**P**</u>	<u>**P**</u>	LP	I	I	I
Integration with transport network	<u>**P**</u>	<u>**P**</u>	LP	LP	LP	I
Constructability	<u>**P**</u>	<u>**P**</u>	I	LP	LP	I
Traffic Relief	LP	LP	I	<u>**P**</u>	<u>**P**</u>	I
Environmental						
Ecology	<u>**P**</u>	<u>**P**</u>	LP	I	I	LP
Soils & Geology	I	<u>P</u>	I	<u>P</u>	I	LP
Hydrogeology	LP	I	LP	LP	P	I
Hydrology	P	<u>P</u>	I	I	LP	I
Landscape & Visual	LP	LP	P	LP	I	LP
Archaeology & Heritage	P	P	I	I	I	I
Material Assets - Agriculture	P	P	I	I	I	LP
Material Assets Non-Agriculture	LP	LP	P	I	I	LP
Air & Climate	P	P	P	LP	LP	I
Noise & Vibration	P	P	I	LP	LP	LP
Human Beings	LP	LP	P	I	I	I
Planning	LP	LP	P	LP	LP	P
Economy						

Alternatives	Red Route Option	Orange Route Option	Yellow Route Option	Blue Route Option	Pink Route Option	Green Route Option
Cost Benefits	Included in Section 2					
Overall						
Engineering	P	P	I	LP	LP	I
Environmental	LP	LP	P	I	I	LP
Economy	Included in Section 2					

Note: **P (bold & underlined) = Preferred**, I = Intermediate, LP = Least Preferred;

Table 4.6: Appraisal of Alternatives Matrix – Section 3

Alternatives	**Red Route Option**	**Orange Route Option**	**Yellow Route Option**	**Blue Route Option**	**Pink Route Option**	**Green Route Option**
Engineering						
Length; Integration with transport network; Constructability; Traffic Relief	LP	LP	LP	LP	**P**	I
Environmental						
Ecology	**P**	**P**	**P**	**P**	LP	LP
Soils & Geology	I	I	I	I	**P**	**P**
Hydrogeology	I	I	I	I	LP	I
Hydrology	I	I	I	I	LP	**P**
Landscape & Visual	LP	LP	LP	LP	**P**	I
Archaeology & Heritage	**P**	**P**	**P**	**P**	LP	LP
Material Assets - Agriculture	**P**	**P**	**P**	LP	LP	LP
Material Assets Non-Agriculture	LP	LP	LP	I	**P**	I
Air & Climate	LP	LP	LP	LP	I	**P**
Noise & Vibration	I	I	I	I	**P**	I
Human Beings	I	I	I	I	I	I
Planning	LP	LP	LP	LP	**P**	LP
Economy						
Cost Benefits	Included in Section 2					
Overall						
Engineering	LP	LP	LP	LP	**P**	I

Alternatives	Red Route Option	Orange Route Option	Yellow Route Option	Blue Route Option	Pink Route Option	Green Route Option
Environmental	I	I	I	I	**<u>P</u>**	I
Economy	Included in Section 2					

Note: **P (bold & underlined) = Preferred**, I = Intermediate, LP = Least Preferred

Red and Orange Route Options

The assessment of the Red and Orange Route Options through Section 2 concluded that they are not feasible in so far as they are not deliverable or realisable as they create disproportionate impacts on the sensitive urban environment of Galway City and on its inhabitants, communities and neighbourhoods. The scale and nature of the infrastructure required for the on-line portion of these options is of significant magnitude; this is because the route option would be retrofitted into a sensitive urban environment. The design legacy of such significant heavy engineering solutions associated with these options is likely to radically permanently impact on the experience and image of the city. The scale of this harm is so significant as to deem them to be at significant variance with some of the scheme objectives.

The timescale for the construction of the Red Route Option is of the order of six years, and again the enormity of this construction and the scale of impact could be detrimental to the economy of Galway City, the improvement of which is set as a project objective, as well as having a significant impact on the daily lives of all those impacted by it. The cost of the construction of the Orange Route Option is of such an order as to be the least cost effective alternative, whilst noting that delivery of a cost effective solution is a project objective. It should also be noted that whilst the tunnel avoids direct impacts on many environmental constraints a 3.5km tunnel has the potential to indirectly impact on groundwater and groundwater dependant habitats within the Lough Corrib cSAC and Galway Bay Complex cSAC and their site integrity.

The impacts of the Red and Orange Route Options are considered to be on such a large scale as to be disproportionate to the over-riding need for the road based alternative. Equally as further mitigation by avoidance is very unlikely to improve these route options, these route options were not advanced further.

Yellow Route Options

The Yellow Route Option through Section 2 has similar issues on the on-line section as the Orange and Red Route Options on the eastern side of the city. It has a very significant impact on human beings in the Ballinfoyle area off the Headford Road, with the acquisition of 24 residential properties and an apartment block (37 residential units).

In addition, the Yellow Route Option is likely to have adverse effects on the integrity of Lough Corrib cSAC; and of the route options available, would affect the Qualifying Interests (QI) habitats of the cSAC to the greatest degree. Therefore, the Yellow Route Option was not advanced as there were alternatives available for crossing the Lough Corrib cSAC.

Blue, Pink and Green Route Options

In reviewing all remaining route options (i.e. Blue, Pink and Green), consideration was given to the number of residential properties to be acquired. In each section, an assessment was undertaken under various criteria which sought to balance the potential impact on human beings and ecological constraints and other constraints.

It is acknowledged that the Green Route Option is likely to result in adverse effects on the integrity of Lough Corrib cSAC however it was brought forward for further analysis because it offers an alternative route option which avoids direct impacts on NUIG Sporting Campus and Galway Racecourse.

In the assessment of all route options cognisance was taken of the submissions received as part of the extensive public consultation carried out in respect of the project to minimise the potential impacts on human beings and properties.

The outcome of the robust assessment is that the route option selected was a combination of route options which had the least number of residential properties acquired in each section, i.e. Yellow in Section 1 (modified to reduce potential property impacts), Pink in Section 2 and Pink in Section 3, as shown in bold on **Table 4.2** above, whilst also being the least impacting on the receiving environment. In fact, if the route was further out from the city or in close to the city, there would have been more acquisitions.

4.7.3.7 N59 Link Road Appraisal

During Environmental Workshop No. 4, a review of the constraints and the potential impacts of the N59 Link options was completed in order to select the optimum link connection.

There are three options to connect the N59 to the mainline when the mainline is offset from the N59:

- Orange N59 Link
- Yellow N59 Link/Pink2 N59 Link
- Blue N59 Link

It should be noted that each of the N59 Link Options could be connected with the mainline of the route options, e.g. Orange, Yellow, Blue and Pink. The principal differences between the link options are as follows:

1. The Yellow N59 Link, Pink N59 Link and Blue N59 Link connect to the N59 in the vicinity of Glenlo Abbey whereas the Orange N59 Link connects approximately 1km further south, closer to the city, adjacent to Bushypark Church.
2. The Yellow N59 Link, Pink N59 Link and Blue N59 Link cross at least two local roads whereas the Orange N59 Link does not interact with any local road.
3. The junction form at Glenlo Abbey for the Blue N59 Link will be a priority junction with the N59 realigned along the proposed link and the old N59 tying into it.
4. The junction form at Bushypark Church for the Orange N59 Link will be a signalised junction.
5. The junction form at Glenlo Abbey for the Yellow N59 Link and Pink N59 Link will be a signalised junction.

An engineering appraisal of the N59 Link Road options above under the relevant headings of geometry, length, junction strategy, constructability and traffic was completed.

This assessment showed that the Orange N59 Link is the shortest link with minimal interaction with the surrounding local road network, but the traffic figures on this link are much lower than on the link options to the north namely the Yellow N59 Link, Pink N59 Link and Blue N59 Link. This was attributed to the fact that the mainline of the Orange Route Option did not offer equivalent connection opportunities on the east side of the city as the Yellow, Pink and Blue Route Options. Therefore, the Orange N59 Link was subsequently tested in the traffic model with the emerging preferred route corridor. This showed that the traffic volumes on this link were greater than any of the other link options under consideration. Therefore, from an engineering perspective the preferred N59 Link is the Orange N59 Link.

An environmental appraisal was also carried out on the N59 Link with the key differences being the consideration of human beings and non-agricultural material assets. As noted in above, *Human Beings, Ecology, Landscape and Visual, and Material Assets – Non Agricultural* were identified as disciplines which had key significant constraints. For example, impacts on human beings such as communities and residential property acquisitions and impacts on ecology such as on European designated sites etc. were all key significant constraints which required further consideration during the decision making process.

The Orange N59 Link was the preferred route option from an environmental perspective. It has seven preferred, two intermediate and three least preferred rankings. Three of the seven preferred rankings were for a key environmental discipline, landscape and visual, material assets non-agriculture and human beings. Of the three least preferred rankings, one of these was for a key environmental discipline (ecology). However ecological impacts due to the Orange N59 Link are not on a European site.

The Yellow and Pink N59 Links have been assigned an intermediate ranking. They have five preferred, seven intermediate and no least preferred rankings. Of the preferred rankings, one of these was for a key environmental discipline (ecology).

The Blue Route Option is least preferred from an environmental perspective. The Blue Route Option has two preferred, three intermediate and seven least preferred rankings. Of the five least preferred rankings, three of these were for a key environmental discipline (landscape and visual, material assets non-agriculture and human beings).

On review of the engineering and the environmental assessments of the N59 Link, the overall preference is the Orange N59 Link.

4.7.3.8 Emerging Preferred Route Corridor

The Emerging Preferred Route Corridor (EPRC) was developed as an amalgamation of different route options over two sections, namely R336 to the Galway City boundary and the Galway City boundary to existing N6.

The consensus from the comparative assessment was that the Red, Yellow and Orange Route Options through Section 2 were not feasible in so far as they are not deliverable or realisable due to impacts on the environment including persons, as outlined above. Equally as further mitigation by avoidance is unlikely to improve these route options and these route options were discounted.

Therefore, the preferred route option is the Yellow/Green Route Option over the initial part of Section 1, connecting the Pink Route Option at Barr hAille and follows the path of the Pink Route Option to its termination at the N6 in Coolagh, with the exception of the N59 Link. The N59 Link will comprise the link as presented in the Orange Route Option with a slight modification to tie to the Pink Route Option.

At this point of the route selection process, it was clearly acknowledged and identified that significant engineering infrastructure was required to enable advancement of this preferred route.

As set out at **Section 4.3**, there are a number of constraints within which to work and therefore any proposed road development has to be cognisant of and recognise the constraints existing in a city environment, such as Galway City, that includes Lough Corrib, the River Corrib, Galway Bay and the surrounding natural environment, the presence of designated sites as well as the constraints of the built environment including residential areas of the city itself. These have increased the complexity of the proposed road development and significant engineering interventions are required to address such constraints including:

- River Corrib bridge structure over River Corrib
- Lackagh Tunnel structure beneath Lough Corrib cSAC
- A viaduct structure over non-designated habitat in Menlough

In addition, the desire to reduce the impact of the proposed road development on lands which serve a wide community has driven some significant engineering interventions namely:

- A viaduct structure extending from the River Corrib Bridge to traverse NUIG Sporting Campus
- Galway Racecourse Tunnel structure under the racecourse

Proximity and direct connectivity of the proposed road development are required to serve the strategic traffic accessing Galway City and to deliver the optimum intermodal transport solution within Galway City and its environs with the attendant benefits of the proposed road development. This makes it complex as impacts to the human environment increase with proximity to the urban environment. In addition, it is further complicated and guided by the presence of the designated sites with which any transport solution will interact.

These significant engineering elements formed part of the design measures on the EPRC. Without these significant engineering measures, the Green Route Option would be preferred over Pink, Blue or Yellow Route Options from an ecological perspective through Section 2. However, the Green Route Option had significantly more residential acquisitions as well as significant cultural heritage impacts on Menlough Village.

The provision of the River Corrib Bridge, Menlough Viaduct, Lackagh Tunnel and Galway Racecourse Tunnel are significant infrastructure in proximity to the urban environment but are a justified and proportionate response to deliver a solution in the correct location to solve the transport issues facing Galway City and its environs.

The Emerging Preferred Route Corridor is presented below in **Plate 4.15**.

Plate 4.15: Emerging Preferred Route Corridor

4.8 Route Optimisation

Although the route of the proposed road development has been designed to skirt the city and lands zoned for development, the avoidance of all properties is unfortunately not possible given the linear development of the city with housing along every road radiating out of the city.

The proximity of the proposed road development to the urban environment, which is necessary to provide the optimal transport solution, results in the unfortunate but unavoidable demolition of 44 dwellings to facilitate construction, and the acquisition of a further 10 dwellings due to the impacts on those properties. This is a significant impact on the people living in these homes. However, this must be viewed and considered and balanced with the overall benefits that this proposed road development presents for the future of Galway and its environs and connectivity to the Western Region.

Once chosen, the design of the emerging preferred route corridor (EPRC) has been refined in as much as possible to eliminate and reduce impacts on the human environment. Significant design measures such as steeper earthwork slopes, steepened green embankments and retaining walls have been incorporated in the design to minimise the impact on the human environment. Additional mitigation measures such as noise barriers, landscaping, planting, earth bunding are also utilised to minimise the overall impact on the receiving environment.

Further from an ecological perspective the proposed road development would not have any adverse impacts on the integrity of any European sites.

The process of producing the design from a route corridor was an iterative process. Inputs were received from the environmental specialists, public consultations, submissions, stakeholder commentary and from the over 950 individual landowner meetings and work focused on minimising impacts on homeowners, stakeholders and the environment and refining the layout in order to improve performance.

The incorporation of these inputs resulted in approximately 20% of the length of the route moving outside the published EPRC, which was published in May 2015. Of this 20% only 4% of the route moved wholly outside the EPRC. The more significant alterations which arose as a result of this optimisation are outlined below.

4.8.1 General

Amendments made throughout the length of the proposed road development include development of accommodation works via consultation with directly impacted property owners, refinement of local junction and access arrangement layouts in order to improve accessibility and performance and horizontal alignment alterations in order to minimise impact on property owners. An overview of the major amendments is outlined in the subsequent sections.

4.8.2 Na Foraí Maola to Ballymoneen Ch. 0+000 to 5+640

Following on site consultation meetings and subsequent feedback with landowners in the area of Na Foraí Maola, Troscaigh, Aille, Cappagh, and Ballymoneen area in September 2015 a number of alternative design alteration options were considered. The following is a list of design changes adopted following this consultation:

Na Foraí Maola & Troscaigh Thiar

The design of the proposed road development at Na Foraí Maola and Trosciagh Thiar has evolved since the publishing of the EPRC. The roundabout junction at Na Foraí Maola Thiar which only provided a connection to the local road on the south was removed and replaced with an overbridge link midway between Na Foraí Maola and Troscaigh Road. This also replaced the proposed EPRC overbridge on Troscaigh Road. This overbridge maintains connectivity for pedestrians and local traffic whilst limiting direct access to the proposed road development which has been identified as a strategic route within the TEN-T network. Local access from these areas to the proposed road development are provided at the R336 roundabout in An Baile Nua and Bearna Moycullen Roundabout only.

The horizontal alignment of the mainline of the proposed road development as it changes direction between the R336 Baile Nua and Na Foraí Maola Thiar was changed to a more desirable radius of 510m for a design speed of 85km/h.

Troscaigh Thoir

In Troscaigh Thoir the proposed alignment of the mainline of the proposed road development moved further north away from residential properties on the Ann Gibbons Road. The at-grade roundabout on the Bearna to Moycullen Road moved further south to reduce impacts on a planning permission for a dwelling.

Aille

The proposed mainline of the proposed road development was changed from going over Aille Road on an embankment and bridge structure to go under Aille Road in a cutting and overbridge structure. This was mainly to reduce visual impacts to residential properties north of the proposed road development. The existing Aille local road will be raised by c. 3.5 - 4m at the centre point of the proposed road development to provide adequate headroom and to reduce the excavation depth in rock cutting along the alignment mainline of the proposed road development.

Cappagh

The alignment mainline of the proposed road development was changed at Cappagh Road from an embankment and overbridge to an at-grade roundabout junction. This alteration was incorporated to the design to reduce the landscape and visual impacts of the embankment of the proposed road development on residential properties north and south of the proposed road development and also to provide direct access to the proposed road development from Cappagh Road.

Subsequent to this design change a detailed traffic analysis of traffic movements on all junctions across the proposed road development was undertaken. This analysis recommended that the Cappagh Road Roundabout be changed to a signalised junction to improve overall volume to capacity ratios and also to improve pedestrian and cyclist safety due to its location within the urban environment.

Ballymoneen Road

For similar reasons to the Cappagh Road junction outlined above this same design change was adopted at the Ballymoneen Road Junction where by the roundabout has been replaced with a signalised junction.

4.8.3 Letteragh Junction Area Ch. 7+600

The underbridge at Letteragh Road on the N59 Link Road South was removed and replaced with an at-grade junction with a consequent alteration to the horizontal alignment of the proposed road development. This alteration was incorporated into the design for the following reasons:

- Minimises landscape and visual impacts of bridge over Letteragh Road
- Provides connectivity to National University Ireland, Galway (NUIG) core area and University Hospital Galway (UHG)
- Reduces the traffic on the adjacent local road as reduces diversionary routes to access the proposed road development

The direct connection of the N59 Link Road South to Bóthar Stiofáin was removed and redirected to Gort na Bró Road. This alteration was incorporated into the design as it is a more appropriate connection point for the following reasons:

- Eliminates the conflict between direct accesses from existing homes and traffic accessing the proposed road development
- Minimises impacts on homes on Bóthar Stiofáin
- Separates heavy goods vehicles accessing the Galway West Retail Park from the local movements and vulnerable road users directly accessing onto Bóthar Stiofáin

The horizontal alignment of the proposed road development and the N59 grade separated junction moved westwards by c.150m in order to minimise direct impacts on properties. The diamond grade separated junction was also changed from roundabouts to signalised junctions to improve overall volume to capacity ratios and also to improve pedestrian and cyclist safety along the proposed N59 Link Road.

The mainline also changed from going under the N59 Link Road to going over to reduce overall excavation depths in the rock cutting.

4.8.4 Dangan Bushypark Area

The proposed mainline of the proposed road development moved slightly west c.15-20m in the Dangan/Bushypark area to reduce direct impacts to a local primary school and residential properties. The alignment over the River Corrib was amended to reduce the overall span and skew over the river.

4.8.5 Castlegar Area Ch. 8+300 to 8+800

The horizontal alignment of the proposed road development moved northwards and the elevation was reduced in order to minimise direct impacts on residential properties.

4.8.6 N83/Parkmore Junction Ch. 13+600 to 14+000

The partial grade separated junction on the N83/Parkmore Link Road was replaced with a full movement junction. This alteration was incorporated into the design for the following reasons:

- Caters for the predicted traffic demand utilising the Parkmore Link Road to/from the east
- Improves the capacity of the existing N6 Briarhill Junction as traffic coming from the east which is bound for Parkmore Industrial Estate and Ballybrit Industrial Estate remains on the proposed road development until the proposed exit at Parkmore Link Road
- Improves the capacity of the existing N6/N83 Tuam Road Junction as traffic is retained on the proposed road development
- Frees road space on the existing N6 between the N6/N83 Tuam Road Junction and the proposed Coolagh Junction

4.8.7 Parkmore Link Road Ch. 14+400

The alignment of the Parkmore Link Road has been moved slightly east in order to protect the historical Parkmore mass path and facilitate the future expansion of Boston Scientific’s existing facility.

The eastern link road within the Ballybrit Business Park has been removed and an at-grade signalised junction connection to the existing N6 has been incorporated into the design at this location for the following reasons:

- Eliminates duplication of road provision as minimal demand on this eastern link road
- Avoids impact on the track and boundary drain at Galway Racecourse at a particularly tight area where the emerging preferred route corridor was close to the racetrack
- The GTS recommends a primary cycle route network along the existing N6 at this location. The junction provides improved connectivity to the existing N6 at this location for all traffic modes especially for vulnerable road users as currently there is no provision for the desire line to the large employment centres at the eastern end of Ballybrit Business Park

The current alignment of Parkmore Link Road ties-in at grade to the north of the existing IDA owned cul-de-sac road. The current design provides safe passage for all modes of transport as it consists of 2m cycle lanes and 2m pedestrian footways on the proposed new alignment.

Within the Galway Transport Strategy, *"specific emphasis is also placed on improving connectivity and permeability, within and to the industrial sites to the east of the city, including to, from and between Ballybrit and Parkmore Industrial Parks"*. In this context, the proposed 'Parkmore Link Road' forms part of the Galway Transport Strategy 'Primary Cycle Network', providing a new direct connection to and through Ballybrit Business Park and onwards to Parkmore Industrial Estate. The overall aspiration of the proposed cycle network is *"to provide a safe and comfortable environment for cyclists in the city and surrounding areas, in turn supporting an increase in the number of cyclists and encouraging a greater mode shift from the private car to cycling"*.

The strategic cycling aim of the Galway Transport Strategy primary cycle network is to "*provide a convenient and safe route for medium-distance radial commuter / leisure journeys"*. The primary cycle network through Ballybrit Business Park and along the proposed Parkmore Link Road will therefore have dedicated, segregated cycle facilities and make provision for new or improved pedestrian facilities.

Specifically, it is the intention of the Galway Transport Strategy to *"ensure that the needs of pedestrians, including the mobility impaired and disabled, are fully considered in the design of all new facilities and upgrades of existing facilities….Permeability is a key constraint for cyclists and pedestrians in Galway. Links between residential areas and workplaces alike will be continuously improved as part of a structured, prioritised implementation programme based on the above principles"*.

The Galway Transport Strategy recognises that the integration of land-use and transportation is essential in creating sustainable living. The Galway Transport Strategy states that *"the primary goals of land-use and transport integration in responding to the need to travel may be summarised as follows:*

- **Reducing** the need to travel;
- **Reducing** the distance travelled;
- **Reducing** the time taken to travel;
- **Promoting** walking and cycling; and
- **Promoting** public transport use."

The Galway Transport Strategy therefore incorporates specific land use principles to guide development in Galway, including:

- *New development areas should be fully permeable for walking and cycling and the retrofit of walking and cycling facilities should be undertaken where practicable in existing neighbourhoods, in order to give a competitive advantage to these modes;*
- *Where possible, developments should provide for filtered permeability. These would provide for walking, cycling and public transport and private vehicle access but at the same time would discourage through trips by private car;*
- *To the extent practicable, proposals for right of way extinguishments or other requirements should only be considered where these do not result in more*

circuitous walking and cycling trips for local residents accessing public transport or local destinations; and

- *In urban areas, including the numerous towns, villages and settlements, the Design Manual for Urban Roads and Streets (DMURS) will guide localised proposals with a view to reaffirming walking, cycling and public transport modes over the private car.*

The current design of the Parkmore Link Road is in compliance with the design basis set out in the Galway Transport Strategy and this is reflected in the bus routes and cycle network therein, refer to **Plate 4.16** and **4.17**. It serves as the most efficient and shortest public transport route and is along the pedestrian and cyclist desire line. With the advancement of the Parkmore Link Road, pedestrian and cycle access to this employment area is improved significantly.

Plate 4.16: Proposed Bus Routes per Galway Transport Strategy

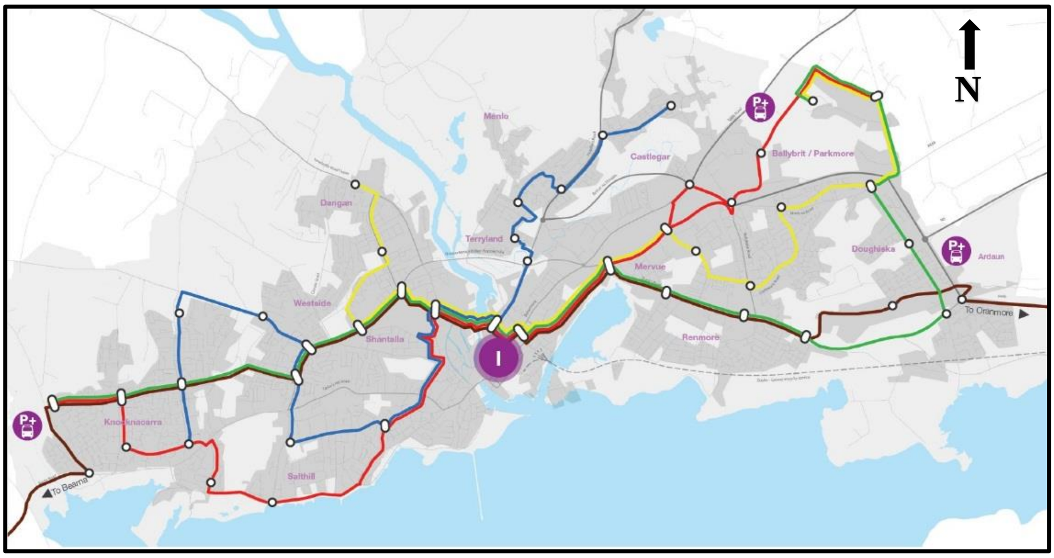


Plate 4.17: Proposed Cycle Network per Galway Transport Strategy

As can be seen above, the linking of the industrial estates via the Parkmore Link Road provides a more direct route from the city centre and western suburbs to the employment areas in the north east quadrant.

4.8.8 Galway Racecourse Tunnel Ch. 14+000 to 15+150

A design change to the proposed Galway Racecourse Tunnel was adopted following a peer review with the Transport Infrastructure Ireland (TII) tunnel operations team. This review considered the long-term operational and maintenance requirements associated with an 850m cut and cover tunnel in addition to the capital cost of its construction. Following this review an exercise was carried out to assess the viability of shortening the overall tunnel length and moving the alignment north to facilitate an open cut section. Following this assessment, it was concluded that a shorter, 240m long tunnel and realignment to the north was preferable to the previous longer design in terms of overall safety and long term operational requirements of the proposed Galway Racecourse Tunnel. This is in addition to the cost savings provided by the shorter tunnel.

In summary the short tunnel option provided the following benefits:

- Reduced operation and maintenance costs
- Reduced construction costs
- Reduced construction programme
- Reduced construction risks
- Reduced interface with Galway Racecourse operations, most notably during construction
- Reduced risks to Galway Racecourse operations due to reduction of overlap between construction and racecourse operations
- Due to the limitation of a nine-month construction window which is required to accommodate the racecourse operations there is a significant increase in time available to excavate rock in the open section of the proposed road development which is no longer within a tunnel or Galway Racecourse lands
- No mechanical tunnel ventilation system required
- No requirement for a deluge system for fixed fire suppression
- Water supply storage and water retention sumps are significantly reduced due to extent of tunnel and absence of deluge fire suppression system
- Removal of 85km/h reduced design speed through shorter tunnel section as alignment allows 100km/h design speed in area
- Significant reduction in carbon footprint due to shorter tunnel and reduced maintenance requirements
- More economical solution over the life time of the proposed road development
- It has been observed that there is a higher rate of accidents at tunnel portal locations. The redesign removes the conflict of the eastbound merge and westbound diverge with the western tunnel portal

- Slip ramps on revised N83 Junction do not require a departure from design standards thereby enhancing safety, operational performance and junction consistency. Standard slip road geometry presents road users with clear unambiguous decision points allowing smooth and safe merge and diverge movements. Consistent merge and diverge layouts across the scheme eliminate driver confusion and aid driver interpretation of junction layouts. The proposed layout is more amenable to future modification, if required, than the original design for the most part as a result of the relocation of the tunnel portal away from the junction

4.8.9 Monivea Road - Coolagh Ch. 15+150 to 17+450

Following the Phase 3 on site geotechnical investigations, the vertical alignment of the proposed road development was altered to cross over the R339 Monivea Road and Briarhill Business Park Road. This is due to the discovery of a high water table in the area and the consequential impacts associated with being in cut in this area.

The layout of the Coolagh Junction has been amended approaching the existing N6. This revised layout has been incorporated into the design for the following reasons:

- Simplifies the proposed junction and the connection to existing N6
- Clearly segregates bypass traffic from traffic accessing the eastern suburbs
- Prioritises national route traffic movements over local route traffic movements
- Provides route continuity for the N6 around Galway City
- Incorporates shorter and more direct links
- Capacity can be increased via upgrade to free flow if demand requires
- Has reduced construction costs and construction complexity

4.9 N6 GCRR – The Optimum Transport Solution

The emerging preferred route corridor for the proposed road development was selected following an extensive evaluation of potential physical and environmental constraints. Route Corridors were analysed through early screening processes to reduce the number of feasible options. The assessment of these options included extensive public consultation exercises and project team workshops. The options were also subject to assessment by an appraisal team independent of the project team. Finally, through further optimisation and avoidance of impacts, the final design corridor was determined.

This preferred route commences in An Baile Nua west of Bearna Village at the R336 and proceeds in a north east direction crossing over the River Corrib in Dangan and connects to the existing N6 at Coolagh. A full overview of the route of the proposed road development is provided in **Chapter 5, Description of Proposed Road Development**.

The proposed road development avoids the greatest number of known and immovable constraints, and utilises the available fabric to greatest extent. It also meets with the requirements of modern road design and of current policy needs.

The design changes made to the proposed road development following the selection of the EPRC further reduce the overall potential environmental impacts on the area and the community without in any way affecting and or altering the selection process carried out. The solution proffered in the proposed road development is the optimum transport solution while also being the preferred option from an environmental perspective, both from a human environment and natural habitat perspective. It incorporates the responses received as part of the extensive public consultation carried out in respect of the project and delivers all of the following:

- Provides a strategic route, forming part of the TEN-T comprehensive network, across the River Corrib without the need to go through the city
- Provides the necessary connectivity to all the national roads and the Western Region and for those living within Galway and the rest of the country
- Provides for strategic traffic accessing Galway City and connectivity with zones of traffic generators and attractors
- It meets the functionality of the road component of the overall intermodal transport solution
- Enables the reallocation of existing road space within the city to public transport and smart mobility measures and is part of a sustainable holistic transport solution
- Alleviates congestion within Galway City which would result in reduced air and noise pollution
- Facilitates a more efficient public transport system
- Facilitates the provision of a multi-modal choice of travel
- Improves safety levels for all public road users
- Minimises property demolition and acquisition as far as possible
- Improves the quality of life of those living within Galway City with a reduction in traffic congestion and hence reduced pollution and an increase in opportunities for physical activity
- The proposed development will deliver the additional crossing of the River Corrib and the new link road as proposed by the GTS. Therefore, the proposed road development forms an essential part of the GTS, it delivers the road component of the overall transport solution for Galway City and its environs, provides benefit to the local and the larger regional population of Galway and the western region and is cognisant of the sensitive environment into which it is interwoven

The proposed road development is going to have negative impacts on the receiving environment including, unfortunately, a significant level of property acquisitions or demolitions that are unavoidable. However, the proposed road development provides the very significant and very much needed benefits to the EU transport network, the Western Region and County Galway as well as the built-up environment of Galway City and environs and the location required for the road infrastructure.

- The routing of thousands of vehicles per day through the city centre brings with it associated and unmitigated impacts on businesses, public facilities, homes and non-motorised road users. These impacts include noise and air pollution. The stop/start nature of urban driving and platooning of vehicles behind slow moving vehicles adds to the levels of pollution experienced by locals and visitors
- The need for the proposed road development from an environmental sustainability perspective is to deliver an integrated, sustainable transport solution that aligns transport investment with settlement patterns, travel movements and also supports a sustainable use of land
- The proposed road development as part of the GTS will reduce car dependency through facilitating a reallocation of road space to improve capacity and reliability of public transport and to facilitate cycling and walking within the city centre core area, with a resultant 16% increase in public transport trips in 2039 when compared to the scenario of not progressing the scheme
- The overall transport solution promotes the reduction of greenhouse gas emissions as it facilitates the advancement of a low-carbon and more energy efficient transport system, whilst also providing accessibility and connections to the city
- This also reduces the level of pollution within the city centre
- It will also bring an additional positive impact on air quality where traffic is diverted away from the receptors along the existing road network within the city centre
- The provision of improved walking and cycling facilities will also have the added benefit of increased physical activity for the city population, which is now of national importance as national policy includes a requirement to include physical activity as one of the criteria against which all projects incurring public funds must be assessed
- Existing impacts on the receiving environment at present include severance effects of traffic congestion in urban areas and traffic speeds on minor roads in rural areas as local roads are used to avoid the congested national road network. This severance will be reduced by the transfer of traffic to the proposed road development

The benefits which the proposed road development facilitate far outweigh the potential negative impacts on the receiving environment and the current design is a proportionate response to the significant transport issues outlined in **Chapter 3, Need for the Proposed Road Development** and summarised above in **Section 4.2**.

5 Description of Proposed Road Development

5.1 Introduction

The proposed N6 Galway City Ring Road (GCRR), hereafter referred to as the proposed road development, comprises the construction of approximately 5.6km of a single carriageway from the western side of Bearna as far as the Ballymoneen Road and approximately 11.9km of dual carriageway from Ballymoneen Road to the eastern tie in with the existing N6 at Coolagh, Briarhill, and associated link roads, side roads, junctions, structures and localised works to the existing electricity transmission and distribution networks (specifically comprising of the diversion of the 110kV and 38kV services). The section of the proposed road development from the tie-in with the R336 Coast Road to the N59 Letteragh Junction is a protected road[1] and the section from this junction to the tie-in with the existing N6 at Coolagh, Briarhill is a motorway.

The total area within the footprint of the development boundary is approximately 280ha. Of this total area, an area of approximately 180ha is required for the proposed road development construction works.

5.2 Background

As discussed in **Chapter 4, Alternatives Considered** there are a number of constraints within which to work and the evolution of the proposed road development took cognisance of and recognised the constraints existing in a city environment, such as Galway City, that includes Lough Corrib, the River Corrib, Galway Bay and the surrounding natural environment, the presence of designated sites as well as the constraints of the built environment of the city itself. Elements were included in the design, which allowed the proposed road development to avoid or reduce direct and indirect impacts on sensitive environmental receptors including persons and businesses potentially affected.

These avoidance measures which are incorporated as part of the design include the following:

- A bridge over the River Corrib with no instream piers and the piers located in areas of non-Annex I habitat
- A viaduct structure extending from the River Corrib Bridge to traverse NUIG Sporting Campus
- A viaduct over non-designated priority Annex I habitat at Menlough

[1] A protected road means a public road or proposed public road specified to be a protected road in a protected road scheme approved by the An Bord Pleanála. A protected road scheme approved by An Bord Pleanála may provide for the prohibition, closure, stopping up, removal, alteration, diversion or restriction of any specified or all means of direct access to the protected road from specified land or from specified land used for a specified purpose or to such land from the protected road.

- A tunnel beneath a narrow section of the Lough Corrib cSAC in Menlough at Lackagh Quarry
- A retaining wall on the southern side of the proposed road development at approximately Ch. 9+880 to Ch. 10+050 and on both sides of the proposed road development at approximately Ch. 10+850 to Ch. 11+150 to avoid the encroachment on Annex I habitat within the Lough Corrib cSAC
- A retaining wall on the southern side of the proposed road development at approximately Ch. 8+340 to Ch. 8+380 to reduce the potential impact on a private property
- Galway Racecourse Tunnel structure under the racecourse
- Lowering of the proposed road development from an overbridge to at-grade junction at Cappagh Road and changing from an overbridge at Hynes' Bóithrín in Castlegar from being in a cutting to at-grade to reduce the potential impacts on private properties
- Movement of the N59 Letteragh Junction further west and revision of the Coolagh Junction to avoid private dwellings

The provision of the above structures in the proposed road development have facilitated the avoidance of more densely populated areas of Galway City and avoided the acquisition of additional properties.

5.3 Proposed Road Development Description

5.3.1 Overview

The proposed road development is located in Galway as shown on **Figure 1.1** with the proposed plan layout shown on **Figures 5.1.01** to **5.1.15** and the plan and profile of mainline and side roads shown on **Figures 5.2.01** to **5.2.15** and **Figures 5.3.01** to **5.3.21**, respectively.

The proposed road development ties into the existing R336 Coast Road in An Baile Nua with an at-grade roundabout junction approximately 2km to the west of Bearna Village and then proceeds north and east as a single carriageway to the north of Bearna Village and onwards towards Ballymoneen. Local connectivity is maintained via the Troscaigh/Na Foraí Maola Overbridge Link whilst an at-grade roundabout is proposed at the Bearna to Moycullen (Maigh Cuilinn) Road L1321. At-grade signalised junctions are proposed at Cappagh Road and Ballymoneen Road.

To the east of the Ballymoneen Road Junction, the proposed road development is a dual carriageway and continues east to the grade separated N59 Letteragh Junction located in Letteragh. The junction connects to the N59 Moycullen Road via the proposed N59 Link Road North, and to the Letteragh Road and Rahoon Road via the proposed N59 Link Road South. The proposed road development continues eastwards to cross the existing N59 Moycullen Road at Dangan and travels on a viaduct over the NUIG Sporting Campus before crossing the River Corrib on a bridge structure. The total length of the structure through the NUIG Sporting Campus and over the River Corrib Bridge is 620m.

It is proposed to construct an all-weather full size GAA pitch and a training pitch at the location of the existing GAA pitches at the NUIG Sporting Campus. The NUIG Sports Pavilion will be modified and will continue to function as a sports facility post construction.

East of the River Corrib the proposed road development continues east on embankment toward the Menlough Viaduct. Additional lands to the north of Menlo Castle are included as part of the proposed development to provide lands for the enhancement of the core foraging habitat for the Lesser horseshoe bat known to roost at Menlo Castle and to mitigate against potential impacts to this species. These lands will be planted with additional hedgerows, maintained as agricultural lands by the local authority and will remain in their ownership.

Continuing east the proposed road development crosses over Bóthar Nua in the townland of Menlough and remains on a viaduct section, Menlough Viaduct (length 320m), towards Seanbóthar before entering a section of cut preceding Lackagh Tunnel (length 250m) immediately west of Lackagh Quarry, and exits the tunnel in the quarry. There is a tunnel maintenance building located adjacent to Lackagh Tunnel.

The proposed road development continues east with a grade separated junction located at the N84 Headford Road Junction at Ballinfoyle and continues east through the townland of Castlegar to the grade separated junction at N83 Tuam Road[2]. This junction provides access to both the N83 Tuam Road and the proposed Parkmore Link Road between the Ballybrit Business Park and the Parkmore Industrial Estate via the proposed City North Business Park Link road to provide full connectivity at this location.

The proposed road development then continues eastwards entering the Galway Racecourse Tunnel (length 230m) at Ballybrit to the north of the racetrack. There is a tunnel maintenance building located adjacent to the Galway Racecourse Tunnel and new stables provided for the Galway Racecourse. On emerging from the tunnel, the proposed road development continues south, crossing over the R339 Monivea Road on embankment and continuing south to enter a cutting as it reaches its junction with the existing N6 at Coolagh Junction. The proposed Coolagh Junction will be a fully grade separated junction with partial free flow on the major movements.

The proposed road development will also include extensive landscape planting for screening and the creation of specific habitat areas to compensate for loss of habitat elsewhere. To mitigate noise impacts across the proposed road development, a low noise road surface (LNRS) will be incorporated to reduce noise at source. In addition, an extensive scheme of noise barriers has also been incorporated into the design to further reduce noise levels along the proposed road development.

[2] Formally known as the N17 Tuam Road.

The proposed road development has been designed to a sufficient level of detail for a full environmental impact assessment of all potential direct and indirect impacts.

5.4 Design Standards

The design of the mainline, junctions, link and connector roads and non-motorised user facilities for the proposed road development have been completed in accordance with the TII current design standards available on the TII Publication's website, the TII Manual of Contract Documents for Road Works (MCDRW), the Department of Transport's Design Manual for Urban Roads and Streets (DMURS) and the National Transport Authority's National Cycling Manual. As the proposed road development is spread between urban and rural environment consideration has been given to allow for safe provision of non-motorised users within the proposed development boundary using the above standards. The following TII Publications are particularly relevant to the design:

- DN-GEO-03031 – Road Link Design
- DN-GEO-03060 – Geometric Design of Junctions (priority junctions, direct accesses, roundabouts, grade separated and compact grade separated junctions)
- DN-GEO-03036 – Cross-Sections and Headroom
- Design Manual for Urban Roads and Streets
- National Transport Authority, National Cycling Manual

In addition to the above design documents further guidance was drawn as necessary from relevant published data.

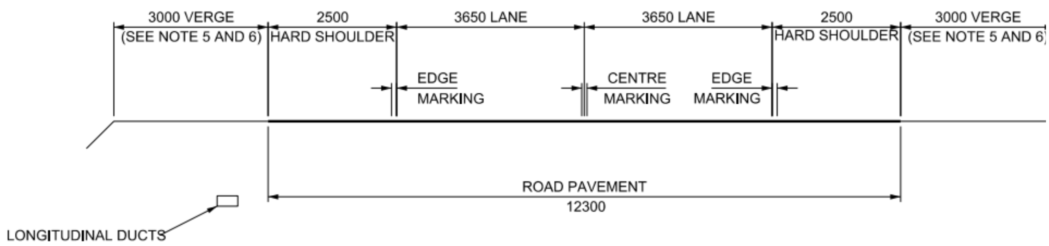
5.5 Proposed Road Type and Cross-Section

5.5.1 Mainline

From the R336 Coast Road to Ballymoneen, the mainline of the proposed road development is a Type 1 Single Carriageway in accordance with TII Publication DN-GEO-03036 (Cross Sections and Headroom). This section of mainline will be designated as a protected national road. The design speed of the mainline over this area is 85km/h. The cross section, shown in **Plate 5.1**, is as follows:

Western Verge Width (minimum):	3.0m
Western Hard Shoulder:	2.5m
Carriageway Width:	7.3m (2 x 3.65m lanes)
Eastern Hard Shoulder:	2.5m
Eastern Verge Width (minimum):	3.0m
Total Width (minimum):	**18.3m**

Plate 5.1: Typical cross section of the Type 1 Single Carriageway Link from the R336 to Ballymoneen



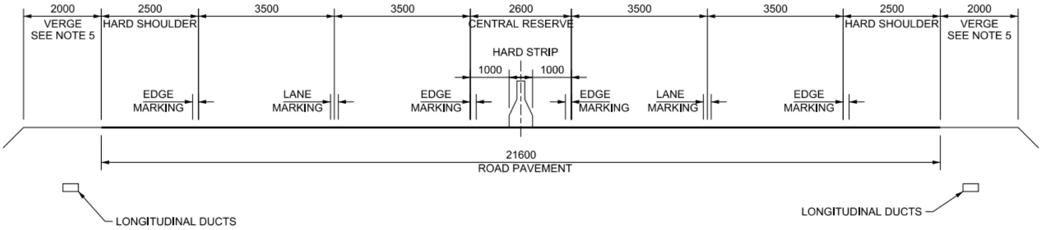
Climbing lanes are incorporated on the single carriageway at two locations, one in the eastbound direction and one in the westbound direction. These are designed in accordance with DN-GEO-03031.

From Ballymoneen Road to the eastern tie in with the existing N6 at Coolagh, Briarhill the mainline of the proposed road development is a Standard Dual Carriageway Urban Motorway (D2UM) in accordance with DN-GEO-03036. The mainline from Ballymoneen Road to the N59 Letteragh Junction will be designated as a Protected National Road and the mainline from the N59 Letteragh Junction to the N6 Coolagh Junction will be designated as a motorway, however, the cross sections remain the same. The design speed of the mainline over this area is 100km/h. The cross section, illustrated by **Plate 5.2**, is as follows:

Western Verge Width (minimum):	3.0m
Western Hard Shoulder Width (minimum):	2.5m
Western Carriageway Width:	7.0m (2 x 3.5m lanes)

Central Reserve Width (minimum):	2.6m (including 2 x 1.0m offside hardstrip)
Eastern Carriageway Width:	7.0m (2 x 3.5m lanes)
Eastern Hard Shoulder Width (minimum):	2.5m
Eastern Verge Width (minimum):	3.0m
Total Width (minimum):	**27.6m**

Plate 5.2: Typical cross section of the Dual Carriageway Urban Motorway Link from Ballymoneen to Coolagh



Between the N84 Headford Road Junction and the N83 Tuam Road Junction the mainline cross section will widen to 34.6m to accommodate a third lane in each direction (3 x 3.5m lane). This is to cater for the forecasted traffic between these junctions.

The cross sections at the River Corrib Bridge and Menlough Viaduct consist of the same as described above with the exception of the hard shoulder width which is reduced to 0.5m and a raised verge of 0.6m (excluding widening requirements for visibility).

The cross sections of the Lackagh Tunnel and the Galway Racecourse Tunnel differ from that required for a Standard Dual Carriageway Urban Motorway in accordance with DN-GEO-03036. These cross sections are dictated by national and international best practice with respect to tunnel layouts, geometric parameters such as stopping sight distance, the provision of space for operational equipment and the provision of safe access and egress in cases of emergency. Cross sections of both tunnels consist of 2 x 3.75m lanes in both directions, minimum nearside and offside 0.5m hard strip (excluding widening requirements for visibility) and 1.2m walkways nearside and offside. A minimum maintained headroom of 5.3m is provided in both tunnels.

5.5.2 Link Roads

There are four main link roads included as part of the proposed road development:

- N59 Link Road North
- N59 Link Road South
- Parkmore Link Road
- City North Business Park Link

A signalised grade separated junction at Letteragh connects the proposed road development to the N59 Moycullen Road via the N59 Link Road North and to the Rahoon and Letteragh Roads to the south via the N59 Link Road South.

The Parkmore Link Road forms part of the N83 Tuam Road Junction. The Link Road connects the Parkmore Industrial Estate to Ballybrit and City East Business Parks, providing a new access/egress to these estates as well as to the N83 Tuam Road. Access to the N83 Tuam Road is facilitated via City North Business Park Link. All link roads described above consist of a footpath in either direction with a minimum width of 1.8m in accordance with DN-GEO-03036. These link roads are detailed below in **Table 5.1**.

Table 5.1: Link Roads

Road Name	Lane Width	Footpath	Cycle Lane	Length	Chainage
N59 Link Road North & South	2 x 3.5m	Min 1.8m	2.0m (Ch. 1+500 – 2+220)	2200m	Ch. 7+575
City North Business Park Link	2 x 3.5m	Min 1.8m	2.0m	420m	Ch. 14+000
Parkmore Link Road	2 x 3.5m	Min 1.8m	2.0m	1350m	Ch. 14+375

5.5.3 Side Roads

Side roads which require redesign and realignment for the proposed road development have been designed in accordance with the standards noted in **Section 5.4**. **Table 5.2** details all side roads, both online and offline.

Table 5.2: Side Roads

Road Name	Lane Width	Length	Approx. Chainage	Comment
R336 Coast Road West	2 x 3m	245m	Ch. 0+030	Realignment of R336 Coast Road west to proposed roundabout, Bearna West Roundabout, at Baile Nua.
R336 Coast Road East	2 x 3m	90m	Ch. 0+030	Realignment of R336 Coast Road east to proposed roundabout, Bearna West Roundabout, at Baile Nua.
Na Foraí Maola to Troscaigh Link Road North	2 x 3m	500m	Ch. 1+400	Link road to connect existing local roads north and south of the proposed mainline via overbridge.
Na Foraí Maola to Troscaigh Link Road South	2 x 3m	730m	Ch. 1+400	Link road to connect existing local roads north and south of the proposed mainline via overbridge.
Na Foraí Maola to Troscaigh Overbridge Link	2 x 3m	200m	Ch. 0+190	Link road connecting Na Foraí Maola to Troscaigh Link Road North and Na Foraí Maola to

Road Name	Lane Width	Length	Approx. Chainage	Comment
				Troscaigh Link Road South.
L1321 Bearna to Moycullen Road North	2 x 3m	170m	Ch. 2+800	Realignment and tie into proposed Bearna East Roundabout.
L1321 Bearna to Moycullen Road South	2 x 3m	170m	Ch. 2+800	Realignment and tie into proposed Bearna East Roundabout.
L5384 Aille Road	2 x 3m	270m	Ch. 3+310	Realignment of L5384 Aille Road for proposed mainline underbridge.
Cappagh Road North	2 x 3m	140m	Ch. 4+450	Realignment and tie into proposed signalised junction.
Cappagh Road South	2 x 3m	230m	Ch. 4+450	Realignment and tie into proposed signalised junction.
Ballymoneen Road North	2 x 3m	230m	Ch. 5+650	Realignment and tie into proposed signalised junction.
Ballymoneen Road South	2 x 3m	130m	Ch. 5+650	Realignment and tie into proposed signalised junction.
Rahoon Road	2 x 3m	290m	Ch. 6+350	Redesign of Rahoon Road at Mincloon to accommodate mainline overbridge.
Clybaun Road	2 x 3m	410m	Ch. 6+350 to Ch. 6+650	Redesign of Clybaun Road at Mincloon to accommodate mainline overbridge and staggered junction.
Rahoon Road	2 x 3m	290	N59 Link Road Ch. 2+200	Redesign Rahoon Road at Gort na Bro to tie to proposed signalised junction with Letteragh Link Road South.
Gort na Bró Road	2 x 3m	270m	N59 Link Road Ch. 2+200	Redesign of Gort na Bró Road to tie to proposed signalised junction

Road Name	Lane Width	Length	Approx. Chainage	Comment
				with Rahoon Road (Rahoon Road Junction) and N59 LRS+.
Letteragh Road	2 x 3m	780m	Ch. 7+250	Redesign of Letteragh Road to tie into proposed signalised junction with Letteragh Link Road South and proposed mainline overbridge.
N59Moycullen Road	2 x 3.5m	350m	N59 LRN* Ch. 0+000	Redesign of N59 Moycullen Road at Bushypark to tie in to proposed signalised junction with Letteragh Road North.
N59Moycullen Road	2 x 3.5m	390m	Ch. 8+500	Redesign of N59 Moycullen Road at Dangan to accommodate proposed mainline overbridge.
Bóthar Nua	2 x 3m	260m	Ch. 10+110	Redesign of Bóthar Nua at Coolough to accommodate proposed mainline overbridge.
Sean Bóthar	2 x 3m	250m	Ch. 10+475	Realignment and tie into existing.
N84Headford Road	2 x 3.5 lanes transitioning to 4 x 3.5m	400m	Ch. 12+125	Redesign of N84 Headford Road to accommodate proposed grade separated junction.
School Road L2134	2 x 3m	240m	Ch. 13+150	Redesign of L-2134 School Road, Castlegar to accommodate proposed mainline underbridge.
N83Tuam Road	2 x 3.5 lanes transitioning to 4 x 3.5m 1x3.25m Bus Lane	1060m	Ch. 14+000	Redesign of N83 Tuam Road to accommodate proposed grade separated junction.

Road Name	Lane Width	Length	Approx. Chainage	Comment
N6 Bóthar na dTreabh at City East Business Park	4 x 3.5m lanes	300m	N/A	Provision of signalised junction access from N6 Bóthar na dTreabh to City East Business Park.
Briarhill Business Park Road	2 x 3.5m lanes	190m	Ch. 15+730	Redesign of Briarhill Business park road to accommodate proposed mainline overbridge
R339Monivea Road	2 x 3.5m	275m	Ch. 15+850	Redesign of Monivea Road R339 to accommodate proposed mainline overbridge
Ballybrit Crescent	2 x 3.5m	200m	Ch. 15+850	Redesign of Ballybrit Crescent Road

Note: *N59 LRN = N59 Link Road North
+N59 LRS = N59 Link Road South

5.5.4 Other Design Aspects

This section describes the design of other aspects of the proposed road development. Reference is made to the relevant guidance on which the design is based.

5.5.4.1 Traffic Signs

Signage will be provided along the proposed road development to ensure that clear directional and regulatory messages are transmitted to drivers and other road users and has been included in the design. The design of the signs and road marking is based on the 2010 Traffic Signs Manual issued by the Department of Transport and complemented by series 1200 of TII MCDRW, the National Cycle Manual by the National Transport Authority, and the Design Manual for Urban and Streets (DMURS) also compiled by the Department of Transport. There are 29 gantries signs, which will support advanced directional signage, proposed as part of the proposed road development.

5.5.4.2 Pedestrian and Cyclist Provision

As outlined in previous chapters of this EIAR, the proposed road development is a key element of a wider transportation strategy for Galway City and its environs, the Galway Transport Strategy (GTS). The GTS examines and provides for the needs of all modes of transport including but not limited to cyclists, pedestrians, public transport users, private motorists etc. Information on this strategy can be obtained by visiting the Galway City Council website (http://www.galwaycity.ie/galway-transport-strategy/).

The proposed road development interacts with the existing road network at numerous locations along its extent. The existing networks at these locations act as multi modal corridors and as a result required particular attention and care when designing suitable provisions. An overview of the interactions along the extent of the proposed road development along with the provisions at each location is detailed below.

Bearna West Roundabout

The Bearna West Roundabout is located on the R336 Coast Road west of Bearna Village. Footpaths are provided on each arm of the junction which facilitates pedestrian crossings away from the flaring of the approaches.

Na Foraí Maola to Troscaigh Overbridge

An overbridge with footpaths on both sides is provided in this area. These footpaths extend from the structure along the upgraded overbridge link road to maintain connectivity north and south of the proposed road development to the Na Foraí Maola and Troscaigh area.

Bearna East Roundabout

The Bearna East Roundabout is located on the Bearna to Moycullen Road (L1321) north of Bearna Village. Footpaths are provided on each arm of the junction which facilitates pedestrian crossing away from the flaring of the approaches. The area is remote from amenities and services and there is low pedestrian activity in the area.

An Chloch Scoilte

An overbridge is provided in this area. There is no direct connection provided to the mainline of the proposed road development. Footpaths are provided on the overbridge. These footpaths extend from the structure along the upgraded Aille Road (L5384) and connect into the An Chloch Scoilte Road (L5385).

Cappagh Road Junction

A signalised junction is provided in order to enhance operational safety and performance and to facilitate the efficient movement of all road users. Footpaths are provided on each arm of the junction. These footpaths connect into the existing networks in the area.

Ballymoneen Road Junction

A signalised junction is provided in order to enhance operational safety and performance and to facilitate the efficient movement of all road users. Footpaths are provided on each arm of the junction. These footpaths connect into the existing networks in the area.

Rahoon Road

An underbridge is provided in this area. There is no direct connection provided to the mainline of the proposed road development. Footpaths are provided on the Rahoon Road. These footpaths extend from the structure along the upgraded Rahoon Road and connect into the existing road network.

Letteragh Road

A signalised junction is provided in order to enhance operational safety and performance and to facilitate the efficient movement of all road users. Footpaths are provided on each arm of the junction. Dedicated footways are provided through the junction on the N59 Link Road South, a dedicated cycleway is provided on the southern arm of this junction to Rahoon Road as per the GTS. These cycleways and footways connect into the existing networks in the area.

N59 Letteragh Junction

Signalised junctions are provided in order to enhance operational safety and performance and to facilitate the efficient movement of all road users. Dedicated crossing points are provided on each arm of the junction. Dedicated footways are provided through the junction on the N59 Link Road South as per the GTS. These footways connect into the existing networks in the area.

Bushypark Junction

A signalised junction is provided in order to enhance operational safety and performance and to facilitate the efficient movement of all road users. Footpaths are provided on each arm of the junction. Dedicated footways are provided on the N59 Link Road North. The need for this provision arose from the GTS. These footways connect into the existing networks in the area.

Rahoon Road Junction

A signalised junction is provided in order to enhance operational safety and performance and to facilitate the efficient movement of all road users. Footpaths are provided on each arm of the junction. Dedicated cycleways and footways are provided on the N59 Link Road South and footways on the Gort Na Bró Link Road as per the GTS. These cycleways and footways connect into the existing networks in the area.

Gateway Retail Junction

Gateway Retail Junction is a simple junction providing connectivity to the Gort na Bró Road from existing residential areas. The existing network provides dedicated footways and these are maintained in the design.

N59 Moycullen Road Area

An overbridge is provided in the area where the mainline of the proposed road development crosses the N59 Moycullen Road. There is no direct connection provided to the mainline of the proposed road development. Footpaths are provided in the area. These footpaths extend from the location of the structure along the upgraded N59 Moycullen Road and connect into the existing networks.

Bóthar Nua (Coolough Road)

An underbridge is provided in the area where the mainline of the proposed road development crosses Bóthar Nua. There is no direct connection provided to the mainline of the proposed road development. The existing road serves all modes. There are no footpaths or dedicated cycleways in the area. It is not proposed to provide isolated footpaths/cycleways in the area.

Seanbóthar (Menlo)

An underbridge is provided in the area where the mainline of the proposed road development crosses Seanbóthar. There is no direct connection provided to the mainline of the proposed road development. However, there is a diverge from the mainline to Seanbóthar to accommodate the egress of over height and emergency vehicles from Lackagh Tunnel. Seanbóthar is an existing access road which primarily serves agricultural traffic. Footpaths are provided along the section of road beneath the structure.

N84 Headford Road

Dedicated crossing points are provided on each arm of the junction. Dedicated footways are provided through the junction. These footways connect into the existing networks in the area.

School Road Castlegar

An overbridge is provided in this area. There is no direct connection provided to the mainline of the proposed road development. Footpaths are provided on the overbridge. These footpaths extend from the structure along the upgraded School Road (L2134) and connect into the existing road network.

N83 Tuam Road Junction and Parkmore Link Road

Signalised junctions are proposed where diverge and merge arms interact with the existing N83 Tuam Road. Signalised junctions are provided in order to enhance operational safety and performance and to facilitate the efficient movement of all road users. Dedicated crossing points for pedestrians and cyclists are provided on each arm of the junction. Dedicated cycleways and footways are provided through the junction in line with the GTS. These cycleways and footways will connect into the existing and proposed networks in the area. A dedicated inward bus only lane, as per the GTS, is also accommodated within the design.

The Parkmore Link Road is proposed to connect major industrial areas of Galway City. This is an urban street and dedicated cycleways and footways are provided along its length. The Parkmore Link Road is a key component of the GTS which has been identified as being one of the infrastructure measures to cater for public transport between the Ballybrit and Parkmore industrial estates. It facilitates the interchange of bus routes servicing these industrial estates thus increasing the level of provision of public transport into the whole of the north eastern quarter of the city. It also provides a shorter direct route with full provision of appropriate infrastructure along the desire line for both pedestrians and cyclists to the industrial estates of Parkmore and Ballybrit. City North Business Park Link provides connectivity between the proposed Parkmore Link Road and the existing N83 Tuam

Road. This link has dedicated cycleways and footways as per the GTS thereby linking the networks for all modes in the area. All of this culminates in the encouragement of a modal shift to sustainable transport measures.

Signalised junctions are proposed for each junction along the length of the Parkmore Link Road with the exception of Business Park Junctions 1 and 2. Signalised junctions are provided in order to enhance operational safety and performance and to facilitate the efficient movement of all road users. Dedicated crossing points for pedestrians and cyclists are provided at each junction location.

Ballybrit Crescent Junction

Ballybrit Crescent Junction is an existing signalised junction. The upgrade of this junction as part of the proposed road development caters for the requirements of the GTS which includes a dedicated bus lane and dedicated cycle facilities. Footpaths are maintained in the area at the current level of provision.

Lynch Junction

Lynch Junction is an existing signalised junction. This junction was previously upgraded to signalisation to enhance operational safety and performance and to facilitate the efficient movement of all road users. No works are proposed to be undertaken on the Lynch Junction at Briarhill as part of the proposed road development. The proposed road development will connect to the junction only.

City East Business Park Junction

There is currently a merge lane from City East Business Park to the existing N6 at this location. As part of the proposed road development it is proposed to provide a signalised junction. Footpaths are proposed on the City East Business Park Road. Footpaths are not proposed on the N6 Bóthar na dTreabh.

Coolagh Junction

The eastern terminus of the proposed road development connects to the existing N6 at Coolagh, Briarhill. The provision of a full movement, high quality junction at the intersection of the proposed road development and the existing N6 terminus is necessary due to the fact that the N6 is the primary access to Galway from the east and has become the primary access to Galway from the south since the opening of the M17/M18.

The existing road serves all modes. There are no footpaths or dedicated cycleways in the area. It is not proposed to provide isolated footpaths/cycleways in the area as safer alternatives are available. From the signalised junction to the east, motorway restrictions will apply.

The proposed pedestrian and cyclist provisions are shown on **Figures 5.1.01** to **5.1.15**.

5.5.4.3 Fencing and Barriers

At the beginning of the construction phase the land to be acquired as per the proposed development boundary will be fenced and access across it restricted. Temporary construction fencing or hoarding may be required during construction prior to the installation of permanent fencing to secure the site and prevent unauthorised access. Fencing will be erected from the proposed road side of the fence. In areas where the proposed development boundary includes Annex I habitat within Lough Corrib cSAC the permanent fencing will be located between the proposed road and the Annex I habitat and will not be located within the habitat areas.

Fence types will vary across the proposed road development depending on the different requirements and maybe temporary in nature. Fence types will include timber post and rail fencing, masonry walls, steel palisade fencing, noise barriers, parapets etc. Fencing, safety barriers and parapets on the proposed road development will be provided to meet the requirements of the current TII Publications and guidance documents.

Standard detailed fencing typically used on schemes of this nature will be used however site specific requirements may differ between rural and urban environments across the proposed road development. Existing residential and commercial boundary walls impacted by the proposed road development will be replaced.

A vehicle restraint system design has been completed in accordance with DN-REQ-03034 Safety Barriers and DN-STR-03011 (The Design of Vehicle and Pedestrian Parapets). All hazards located within the clear zone have been addressed as per hazard definitions, classifications, and ranking. Fencing within the defined clear zone of vehicular traffic will need to be installed as timber post and tension mesh fencing in accordance with TII Publication DN-REQ-03034. See also **Chapter 8, Biodiversity** for the location of mammal proof fencing and **Chapter 17, Noise and Vibration** for noise mitigation and their associated figures for their locations.

5.5.4.4 Lighting

The road lighting design shall meet the requirements of BS5489-1, IS EN 13201 and the UK DMRB TD 34-07 and TII addendum (DN-LHT-03038). This will ensure that light pollution is kept to a minimum.

The proposed road lighting installation has been considered and designed with limiting light trespass as a key priority.

Multiple measures have been taken to ensure that light is applied only where it is required. In addition to traditional good practice design approaches, modern and emerging technologies have been applied to limit the light spill. For the road lighting, these generally include:

- The use of LED lanterns with well-defined and controlled light beam distributions, mounted on columns with a maximum height of 10m. When compared with traditional discharge lamps and lantern technologies, this will provide a significant reduction in light trespass to surrounding areas and properties

- The lanterns are mounted on bracket arms with a 0° tilt to the horizontal, where a 5° tilt would have been typical with older technologies or in less sensitive areas of application
- The LED lanterns emit 0% of their light above the horizontal, meaning no light is directly emitted into the night-sky. The lanterns have been selected to ensure that light directed behind the lantern is minimised

All of the above factors combine to produce a design that is compliant with the relevant standards previously quoted, but also a design that has paid due attention to the sensitive nature of the surrounding areas. It is proposed to provide public lighting at roundabouts on the proposed road development for reasons of safety. Lighting is also provided at Cappagh Road, Ballymoneen Road, N59 Letteragh, N84 Headford Road, N83 Tuam Road and the Coolagh Junctions and associated slip roads in accordance with TII Guidelines. There will also be lighting provided at the entrances to both the Lackagh Tunnel and Galway Racecourse Tunnel.

The City North Business Park Link, Parkmore Link and N59 Link Road North and South will also be lit as they are urban roads. Lighting will be provided at the car parks for the tunnel maintenance buildings at Lackagh Quarry and Galway Racecourse and the stables at Galway Racecourse. Flood lighting will also be provided at the proposed 3G pitch and training pitch at NUIG.

There is currently lighting on the Ballybrit Crescent Junction, the southern section of the existing N83 Tuam Road (Ch. 14+000), the N59 Moycullen Road and the southern portion of the Rahoon Road at the proposed Rahoon Road Junction. The lighting provision in these areas shall be extended to tie into that of the proposed road development.

The road lighting column heights and their proposed locations along with the potential light spill are shown on **Figures 5.4.01** to **5.4.15**. The proposed lighting for NUIG and the carparks are included in **Appendix A.5.1, A.15.1** and **A.15.2**. The potential direct and indirect impacts of the proposed lighting on ecology is assessed in **Chapter 8, Biodiversity** and on human beings in **Chapter 12, Landscape and Visual** and **Chapter 18, Human Beings, Population and Health**.

5.5.4.5 Earthworks and Road Surfaces

The aspects relating to earthworks such as quantities, proposed site compounds and haul routes are discussed in **Chapter 7, Construction Activities** and **Chapter 9, Soils and Geology**.

The pavement design for all roads has been carried out considering the appropriate design life and axle loading in accordance with current TII document PE-SMG-02002 addendum to HD 24/06 Traffic Assessment and DN–PAV-03021 Pavement and Foundation Design. Low noise surfacing will be used for the full length of the mainline of the proposed road development and at junctions.

5.5.4.6 Structures

The proposed road development includes a total of 164 structures. **Table 5.3** below gives a summary of the 164 structures included in the proposed road development.

Table 5.3: Structures Overview

Structure Group		Overview
Major Structures	River Corrib Bridge	The River Corrib Bridge crosses the River Corrib and through the Lough Corrib cSAC. It is in close proximity to Menlo Castle and traverses the NUIG Sporting Campus. The width of the river at the crossing is approximately 153m.
	Menlough Viaduct	In the vicinity of the Menlough area, the proposed road development will be carried on a viaduct to reduce the potential impacts on Limestone pavement which is immediately adjacent to the Lough Corrib cSAC boundary and a Turlough.
	Lackagh Tunnel	The proposed road development will tunnel under the Lough Corrib cSAC immediately west of Lackagh Quarry with is primary function to avoid direct impacts on Annex I habitats at the surface, namely Limestone pavement and Calcareous grasslands. This tunnel will be constructed in such a way to avoid any deformations to the Annex I habitat at the surface. This tunnel is expected to be constructed using mined tunnels methods (drill and blast). See **Chapter 7, Construction Activities** for further details.
	Galway Racecourse Tunnel	The proposed road development will be accommodated in a 240m cut and cover tunnel in the Ballybrit area to reduce the residual impact on the Galway Racecourse. This tunnel is expected to be constructed using the cut and cover method. See **Chapter 7, Construction Activities** for further details.
Standard Overbridges		This family of structures consists of 7 standard overbridges carrying side roads over the proposed road development. These bridges will typically be 2 or 3 span bridges with clear open spans.
Standard Underbridges		This family of structures consists of 10 standard underbridges carrying the proposed road development over local and regional roads. At local roads, typically a single span portal frame arrangement will be adopted; at regional road crossings configuration with clear open span(s) will be chosen.
Other Structures	Retaining Structures	15 retaining structures are currently identified. These are expected to be of reinforced earth and/or reinforced concrete retaining wall configuration.

Structure Group		Overview
	Culverts & Minor Watercourse crossings	Currently there are approximately 43 culvert type structures, of which 28 are structural, to accommodate drainage and watercourses and wildlife under the proposed road development.
	Sign Gantries	29 sign gantries are to be constructed in accordance with DN-STR-03010 and TII Standard Construction Details for sign gantries.
	Environmental Noise Barriers	56 noise barriers are to be constructed. The location, form and type of the environmental noise barriers are shown on **Figures 17.1.01** to **17.1.14**.

The following is a summary of the main structures to be constructed for the proposed road development:

River Corrib Bridge

The proposed road development crosses the River Corrib on a bridge structure (S08/04) from Ch. 8+850 to Ch. 9+500 (650m in length). The proposed structure comprises of an eight span bridge carrying the proposed road development over the River Corrib adjacent to a retained embankment with five culvert openings on the eastern approach. The proposed structure is a variable depth single concrete box without supports in the river. The proposed structure is a variable depth (between 3m and 7m) single concrete box without supports in the river with the main span over the river being 153m. The adjacent spans consist a variable depth single concrete box increasing in depth from 3m to 7m on approach to the main span. The remaining western approach spans consists of 3m constant depth single concrete box while the remaining eastern approach links into a retaining embankment with five culvert openings to facilitate the passage of wildlife. The superstructure will be supported on reinforced concrete piers. For aesthetic reasons, inclined webs instead of vertical webs are proposed.

Menlough Viaduct

A viaduct structure, Menlough Viaduct (S10/01) is proposed from Ch. 10+100 to Ch. 10+420 is located outside but adjacent to the Lough Corrib cSAC. The total length of the bridge is dictated by the area of priority Annex I habitat over which it crosses, namely Limestone pavement and a Turlough (all of which fall outside of the Lough Corrib cSAC boundary) and this will reduce the potential impact on these habitats. The viaduct has a total length of approximately 320m, and the proposed road development is on embankment on both approaches to it. The viaduct contains eight spans of a similar 40m span length. The span lengths have been adjusted to reduce the impact of the substructure and foundations on the Limestone pavement and Turlough.

The minimum distance between the soffit of the superstructure and the ground level is approximately 1.5m at one pinch point at the location of the high point in the rock outcropping on the western side. The bridge deck superstructure will consist of prefabricated precast post-tensioned beams supporting a cast in-situ concrete bridge deck. The substructure will consist of conventional reinforced concrete piers at intermediate supports while the reinforced concrete bankseats at the abutments will be supported on a reinforced earthworks system. No substructure supports are proposed within the extents of the Turlough.

Lackagh Tunnel

Lackagh Tunnel (S11/01) is 270m long and is located at Ch. 11+150 to Ch. 11+420. The eastern portal of Lackagh Tunnel is located within the inactive Lackagh Quarry, a limestone quarry. The central section of the tunnel will pass under the Lough Corrib cSAC, while the western portal is proposed to be located in agricultural fields, outside of Lough Corrib cSAC.

The primary function of the Lackagh Tunnel and its Western Approach is to transverse the Lough Corrib candidate Special Area of Conservation (cSAC) between Lackagh Quarry and Menlough without directly impacting on the Limestone pavement and Calcareous grass within the Lough Corrib cSAC. This requires a safe method of excavation and construction of the tunnel such that there will be no impact on the Lough Corrib cSAC during the construction or operation of the tunnel, as discussed in **Chapter 7, Construction Activities** and **Appendix A.7.3**.

Galway Racecourse Tunnel

The proposed Galway Racecourse Tunnel (S14/02) consists of a 240m twin tube reinforced concrete cut and cover tunnel with central wall. The purpose of the Galway Racecourse Tunnel is to avoid by design adverse impacts, namely disruption to operations and functioning, on the Galway Racecourse. The proposed mainline passes through the north western corner of Galway Racecourse property and necessitates a cut and cover tunnel from Ch. 14+950 to Ch. 15+190, resulting in a tunnel length of approximately 240m.

Underbridges

There are 10 underbridges identified in the current design, which will carry the proposed road development over local, regional and national roads. All underbridges are single span. Three main types of underbridges are proposed:

- Type 1: Buried reinforced concrete box structure
- Type 2: Bridge deck with reinforced earth wall abutment
- Type 3: Concrete deck with side slopes

The underbridges over National Roads will incorporate open clear spans as appropriate, in recognition of the fact that higher volumes of traffic on these National Roads will make these bridges highly visible.

The proposed standard underbridges are located at chainages stated in **Table 5.4** below, along the proposed road development.

Table 5.4: Standard underbridge mainline chainages

Name of Structure	Approx. Chainage
S06/01 - Rahoon Road Underbridge	Ch. 6+335
S07/01 - Letteragh Road Underbridge	Ch. 7+290
S07/02 - N59 Link Road Underbridge	Ch. 7+570
S08/02 - N59 Moycullen Road Underbridge	Ch. 8+540
S09/01 - Menlo Castle Bóithrín Underbridge	Ch. 9+730
S10/02 – Seanbóthar Underbridge	Ch. 10+520
S12/01 - N84 Headford Road Underbridge	Ch. 12+150
S13/02 - N83 Tuam Road Underbridge	Ch. 13+975
S15/01 - Briarhill Business Park Underbridge	Ch. 15+725
S15/02 – Monivea Road R339 Underbridge	Ch. 15+880

Overbridges

There are seven overbridges proposed and the function of these are:

- Structure S01/01, S03/01, S13/01, and S14/01 are overbridges required to carry local roads over the proposed road development
- Structure S12/02 is required as a mammal crossing (green bridge) over proposed road development
- Structures S16/01 and S16/02 are required at Coolagh Junction to provide free flow access between the R446 and the proposed road development

The proposed standard overbridges are located at chainages stated in **Table 5.5** below, along the proposed road development.

Table 5.5: Standard overbridge mainline chainages

Name of Structure	Approx. Chainage
S01/01 - Na Foraí Maola to Troscaigh Overbridge	Ch. 1+375
S03/01 - Barr Aille Overbridge	Ch. 3+300
S12/02 - Castlegar Wildlife Overbridge	Ch. 12+700
S13/01 - School Road Overbridge	Ch. 13+185
S14/01 - Parkmore Link Road Overbridge	Ch. 14+375
S16/01 - Coolagh Junction Overbridge (EB diverge to R446)	Ch. 16+410
S16/02 - Coolagh Junction Overbridge (EB merge from R446)	Ch. 16+830

Culverts and Underpasses

Hydraulic culverts have been designed to minimise impact on both upstream and downstream flood risk. In addition to the hydraulic requirements for the proposed road development crossings, consideration has also been given to the passage of mammals at some ecologically sensitive areas. Some of the hydraulic culverts have been increased in size to allow passage for a range of mammal species; for example, otters, badgers and bats.

A full list of the culverts and underpasses is provided in **Table 5.6**.

Table 5.6: Culverts and Underpasses

Name of Structure	Approx. Chainage	Function	Other Requirements
C00/00	Ch. 0+550	Mammal Underpass	-
C00/01	Ch. 0+640	Combined Hydraulic Culvert & Mammal Underpass	-
C00/02	Ch. 0+975	Hydraulic Culvert	-
C01/01	Ch. 1+550	Hydraulic Culvert	-
C02/01a	Ch. 2+740	Hydraulic Culvert	-
C02/01b	Ch. 2+840	Combined Hydraulic Culvert & Mammal Underpass	-
C03/01	Ch. 3+040	Combined Hydraulic Culvert & Mammal Underpass	-
C03/02	Ch. 3+350	Hydraulic Culvert	-
C03/03	Ch. 3+920	Combined Hydraulic Culvert & Mammal Underpass	-
C03/04	Ch. 3+640	Combined Hydraulic Culvert & Mammal Underpass	-
C04/01	Ch. 4+100	Combined Hydraulic Culvert & Mammal Underpass	Otter Ledge
C04/02	Ch. 4+895	Combined Hydraulic Culvert & Mammal Underpass	Otter Ledge
C05/01	Ch. 5+270	Mammal Underpass	-
C06/00	Ch. 6+450	Mammal Underpass	-
C06/01	Ch. 6+850	Combined Hydraulic Culvert & Mammal Underpass	-
C06/01b	Ch. 6+850	Mammal Underpass	-
C07/00	Ch. 7+100	Mammal Underpass	-
C07/01a	Ch. 1+620	Hydraulic Culvert	-
C07/01b	Ch. 1+610	Mammal Underpass	-
C07/02a	Ch. 7+210	Combined Hydraulic Culvert & Mammal Underpass	-
C07/02B	Ch. 7+290	Combined Hydraulic Culvert & Mammal Underpass	-
C07/04	Ch. 0+700	Mammal Underpass	-
C08/01	Ch. 8+640	Hydraulic Culvert	-
C08/01a	Ch. 8+450	Mammal Underpass	-
C08/02	Ch. 8+760	Mammal Underpass	-

Name of Structure	Approx. Chainage	Function	Other Requirements
C08/04	Ch. 8+570	Mammal Underpass	-
C08/05	Ch. 8+643	Mammal Underpass	-
C09/01	Ch. 9+525	Mammal Underpass	-
C09/02	Ch. 9+540	Mammal Underpass	-
C09/03	Ch. 9+560	Mammal Underpass	-
C09/04	Ch. 9+570	Mammal Underpass	-
C09/05	Ch. 9+580	Mammal Underpass	-
C09/06	Ch. 9+710	Mammal Underpass	-
C09/07	Ch. 9+920	Mammal Underpass	-
C10/01	Ch. 10+040	Mammal Underpass and spanning over exposed Limestone pavement	-
C10/02	Ch. 10+740	Combined Hydraulic Culvert & Mammal Underpass	-
C10/02a	Ch. 10+740	Mammal Underpass	-
C12/01	Ch. 12+130	Mammal Underpass	-
C12/02	Ch. 12+350	Mammal Underpass	-
C12/03	Ch. 12+390	Mammal Underpass	-
C12/04	Ch. 12+450	Mammal Underpass	-
C13/01	Ch. 13+980	Mammal Underpass	-
C13/02	Ch. 13+710	Mammal Underpass	-

Other Structures

There are a number of other structures incorporated into the proposed road development. These include retaining structures, sign gantries and noise barriers.

The proposed retaining structures are located at chainages stated in **Table 5.7** below, along the proposed road development.

Table 5.7: Retaining structures location

Name of Structure	Approx. Chainage
R04/01	Ch. 4+450
R08/01	Ch. 8+325
R08/02	Ch. 8+390
R08/03a	Ch. 8+475
R08/07	Ch. 8+550
R08/08 (N59 Link Road North)	N59 LRN* Ch. 0+100
R08/09	Ch. 8+400
R09/01	Ch. 9+510

Name of Structure	Approx. Chainage
R09/02	Ch. 9+510
R09/03	Ch. 9+825
R12/01	Ch. 12+300
R14/03	Ch. 14+550
R14/05	Ch. 14+890
R15/01	Ch. 15+630
R15/02	Ch. 15+750

Note: *N59 LRN = N59 Link Road North

It should be noted that there are other retaining structures proposed elsewhere on the proposed road development, for example at the western approach to Lackagh Tunnel, at Structure S11/01, as abutments to overbridges and underbridges, etc. These retaining structures are included with the associated structure.

The proposed sign gantries are located at chainages stated in **5.8** below, along the mainline of the proposed road development.

Table 5.8: Sign Gantries location

Name of Structure	Approx. Chainage	Gantry type	Lateral siting / span	Comments
G06/01	Ch. 6+260	Cantilever	Eastbound verge	Variable Message Sign
G06/02	Ch. 6+950	Cantilever	Eastbound verge	Advance Directional Sign
G08/01	Ch. 8+340	Cantilever	Westbound verge	Advance Directional Sign
G10/01	Ch. 10+075	Cantilever	Eastbound verge	Variable Message Sign
G10/02	Ch. 10+470	Portal	Across Eastbound lanes	Advance Directional Sign Intelligent Transport Sign
G10/03	Ch. 10+600	Portal	Across Eastbound lanes	Intelligent Transport Sign
G10/04	Ch. 10+840	Portal	Across Eastbound lanes	Advance Directional Sign Intelligent Transport Sign
G11/01	Ch. 11+030	Portal	Across entire carriageway	Intelligent Transport Sign
G11/02	Ch. 11+525	Portal	Across Westbound lanes	Intelligent Transport Sign
G11/03	Ch. 11+600	Portal	Across Eastbound lanes & diverge	Directional Sign Intelligent Transport Sign

Name of Structure	Approx. Chainage	Gantry type	Lateral siting / span	Comments
G11/04	Ch. 11+775	Portal	Across Westbound lanes & merge	Intelligent Transport Sign
G12/01	Ch. 12+060	Portal	Across Westbound lanes	Intelligent Transport Sign
G12/02	Ch. 12+450	Portal	Across Westbound merge only	Advance Directional Sign
G12/03	Ch. 12+725	Portal	Across all Westbound lanes	Directional Sign
G12/04	Ch. 12+950	Portal	Across all Eastbound lanes	Advance Directional Sign Variable Message Sign
G13/01	Ch. 13+190	Portal	Across all Westbound lanes	Advance Directional Sign Variable Message Sign
G13/02	Ch. 13+450	Portal	Across Eastbound lanes &diverge	Directional Sign
G13/03	Ch. 13+610	Portal	Across Westbound merge only	Advance Directional Sign
G14/01	Ch. 14+250	Portal	Across Westbound lanes	Intelligent Transport Sign
G14/02	Ch. 14+650	Portal	Across entire carriageway	Directional Sign Intelligent Transport Sign
G14/03	Ch. 14+810	Portal	Across entire carriageway	Advance Directional Sign Intelligent Transport Sign
G15/01	Ch. 15+290	Portal	Across entire carriageway	Advance Directional Sign Intelligent Transport Sign
G15/02	Ch. 15+510	Portal	Across Westbound lanes	Intelligent Transport Sign
G15/03	Ch. 15+690	Portal	Across Westbound lanes	Advance Directional Sign Intelligent Transport Sign Variable Message Sign
G15/04	Ch. 15+820	Cantilever	Eastbound verge	Directional Sign

Name of Structure	Approx. Chainage	Gantry type	Lateral siting / span	Comments
G15/05	Ch. 15+925	Cantilever	Westbound verge	Variable Message Sign
G16/01	Ch. 16+900	Portal	Across Westbound diverge only	Directional Sign
G17/01	Ch. 17+320	Cantilever	Westbound verge	Directional Sign
G18/01	Ch. 18+090	Cantilever	Westbound verge	Variable Message Sign

5.5.4.7 Landscaping

The aspects relating to landscaping are discussed in **Chapter 12, Landscape and Visual**.

5.5.4.8 Drainage

The proposed road development involves the construction of a new drainage system which includes the provision of a surface water collection system, earthworks drainage, sub-surface drainage, attenuation and pollution control, and the culverting of existing streams. The proposed road development has been designed such that surface water drainage and sub-surface drainage will be provided for the proposed mainline carriageway, junctions, link roads and all new sections of local roads.

Due to the contrasting geological features across the extents of the proposed road development, the type of natural drainage can be split into two different broad categories west and east of the N59 Moycullen Road.

The natural discharge of rainfall and surface water drainage west of the N59 Moycullen Road is overland to low points in the topography where shallow ditches and streams are present. The underlying bedrock is granite. This is a low importance, poor aquifer where the bedrock is generally unproductive except for local zones (ref **Chapter 10, Hydrogeology**). In general, the water table is quite close to the surface.

The natural discharge of rainfall and surface water drainage east of the N59 Moycullen Road is directly to ground, with extreme events accumulating at low points and seasonal lakes within the topography. The underlying bedrock is limestone. The aquifer is a regionally important karstified aquifer which is dominated by conduit flow (ref **Chapter 10, Hydrogeology**). Except for the River Corrib, Terryland River, Ballindooley Lough and Coolagh Lakes, there are no other significant watercourses in the area east of the N59 Moycullen Road.

The two different categories of natural drainage inform the approach to drainage design for the proposed road development. As well as the efficient removal of water from the road surface and pavement, the drainage design aims to minimise the impact of runoff from the proposed road development on the receiving environment by replicating, as much as possible, the natural water flows across the proposed road development. This is achieved using a variety of sustainable drainage measures.

All surface water collected by the proposed carriageway drainage system will be discharged to watercourses or existing storm sewers crossed by or adjacent to the proposed road development if present, or will be discharged to ground via infiltration. Flow control measures will be provided at all outfalls and discharge points along the length of the proposed road development to ensure discharge does not cause any adverse effects upstream or downstream of the receiving watercourse or sewer. Infiltration basins have been sized to allow sufficient time for infiltration to discharge to the ground. Pollution control measures will be provided on all mainline road drainage networks prior to outfalling/discharging to ensure that receiving water bodies are not contaminated by runoff from the proposed road development.

In summary, the design basis for the drainage strategy is as follows:

- West of the N59 Moycullen Road the surface water collected by the carriageway drainage system will be discharged into watercourses crossed by, or adjacent to, the proposed road development that eventually outfall to Galway Bay
- East of the N59 Moycullen Road the surface water collected by the carriageway drainage system will be discharged to ground via infiltration, with the exception of two drainage networks (S18A and S18B refer **Figure 11.6.107**) which will discharge directly to the River Corrib and three networks (S14A, S14B and S15 refer to **Figure 11.6.106**) which discharge to tributaries which eventually outfall to the River Corrib

The procedures below have been adopted for the drainage design of the proposed road development in accordance with current TII Publications, guidance documents and best practice methods.

Watercourses

The proposed road development crosses a number of existing watercourses which includes the Bearna Stream and its tributaries, the River Corrib and a number of smaller streams. Streams and rivers will be crossed using culverts or bridge structures.

There is one major river bridge required to cross the River Corrib as outlined in **Section 5.5.4.6**.

As noted in **Section 5.5.4.6**, culverts have been designed to minimise impact on both upstream and downstream flood risk. In addition to the hydraulic requirements for the proposed road development crossings, consideration has also been given for the passage of mammals at some ecologically sensitive areas. Some of the hydraulic culverts have been increased in size to cater for a range of mammal passages for example otters, badgers and bats. **Section 5.5.4.6** summarises the proposed hydraulic culverts and bridge structures.

All of the proposed structures over existing watercourses have been submitted to the OPW for approval under Section 50 of the Arterial Drainage Act and have been approved. Details of required stream realignments in the vicinity of the structures have also been submitted and approved.

There are a small number of Salmonid rivers interacting with the proposed road development. Inland Fisheries Ireland have been consulted regarding the requirements, for fish passage at these locations. The design of all culverts conveying watercourses provides a minimum embedment depth of 150mm on circular culverts or 300mm on rectangular box culverts below stream bed or to the minimum level as requested by Inland Fisheries Ireland. This is to encourage the re-establishment of stream bed ecology. The bed of the channel both upstream and downstream of the culvert should be reinstated with material similar to that removed during construction. This is similar to a “natural” bed contiguous with the existing stream bed, upstream and downstream of the proposed culvert. Proposed culverts encroaching on fish habitats shall be designed to ensure that the velocity of flow will be less than the swimming speed to allow passage of migrating fish. Culverts will be designed such that the velocity in the barrel will not be significantly increased from the velocity of the existing watercourse.

Gradients of proposed culverts will aim to recreate the gradient of the existing watercourse where possible. Where relevant, the culvert design shall accommodate invert baffles to facilitate fish passage upstream and downstream. Suitable measures are to be employed to ensure that livestock are prevented from entering culverts.

Interceptor Ditches

Interceptor ditches are required to intercept the overland flow from the natural catchment adjacent to the proposed road development (both during construction and the operational phases) and to prevent ponding of water adjacent to embankments. The use of interceptor ditches is to prevent drainage from the road curtilage running onto adjacent lands and vice-versa.

The interceptor ditches are provided at the top of the cutting or the base of the embankment where land falls towards the proposed road development to collect overland flow. The ditches have been sized to cater for a 1 in 75 year return period as per DN-DNG-03064 – Drainage of Runoff from Natural Catchments (HD 106). All land drains that are intercepted by the proposed works will be discharged into an interceptor ditch. Scour protection shall be provided where velocities exceed 2.5m/s in the interceptor ditches.

To the west of the N59 Moycullen Road, interceptor ditches will discharge to existing streams, rivers and storm sewers. Due to the undulating nature of the natural topography of the land along the route of the proposed road development, there are some considerable areas of cutting required for earthworks drainage. To the east of the River Corrib, interceptor ditches will discharge to stone filled infiltration trenches located adjacent to the proposed road development. Cross-drains will be provided to convey flow from the interceptor ditches beneath the proposed road development to the outfall/discharge locations where required.

Carriageway Drainage

A surface water collection system will be provided so as to comply with the design requirements of DN-DNG-03022 – Drainage Systems for National Roads (HD33/15). This includes providing suitably sized longitudinal carrier drains to accommodate a 1 year return period storm in-bore without surcharging, with no flooding of the proposed carriageway for a 1 in 5 year return period for filter drains. Where combined surface and ground water drains are proposed, a 1 in 5 year return period storm will not rise above the formation level, or sub-formation level where a capping layer is present. The drainage networks are designed to include an increase of 20% in rainfall depth to cater for the impact of climate change.

In the western section of the proposed road development from the R336 Coast Road to the N59 Moycullen Road, the drainage network is in accordance with Figure 3.1 of DN-DNG-03022 (HD33/15). However, in the eastern section of the proposed road development from the N59 Moycullen Road to the connection point with the existing N6 at Coolagh, Briarhill, due to the karstic nature of the underlying bedrock and the vulnerability of the underlying aquifers, there is a requirement for a fully sealed system to accept the proposed carriageway runoff. Therefore, the network collecting the drainage from the proposed carriageway will be kept separate to the groundwater and sub-surface drainage network. This will be achieved by using either a kerb, gully and carrier pipe system or a surface water channel and carrier pipe system. This allows for controlled treatment of surface waters prior to discharge to the ground thereby reducing the risk to the underlying aquifer. For cuttings and low embankments, a separate filter drain will be provided for sub surface flows **Table 5.9** summarises the proposed mainline drainage networks.

Table 5.9: Summary of Mainline and Junction Drainage Networks

Drainage Network Ref. No.	Mainline / Junction	Chainage	Approx. Total Drainage Area (ha)	Outfalling to	Drainage System Type (Sealed / Non-Sealed)
S1	Mainline	Ch. 0+000 to Ch. 0+700	2.05	Watercourse	Non-Sealed
S2	Mainline	Ch. 0+700 to Ch. 1+000	0.55	Watercourse	Non-Sealed
S3	Mainline	Ch. 1+000 to Ch. 1+475	2.31	Watercourse	Non-Sealed
S4A	Mainline	Ch. 1+475 to Ch. 1+900	0.96	Watercourse	Non-Sealed
S5A	Mainline	Ch. 1+900 to Ch. 2+850	2.45	Watercourse	Non-Sealed
S7A	Mainline	Ch. 2+850 to Ch. 3+050	0.30	Watercourse	Non-Sealed
S7B	Mainline	Ch. 3+050 to Ch. 3+910	2.94	Watercourse	Non-Sealed
S8	Mainline	Ch. 3+910 to Ch. 4+125	0.42	Watercourse	Non-Sealed

Drainage Network Ref. No.	Mainline / Junction	Chainage	Approx. Total Drainage Area (ha)	Outfalling to	Drainage System Type (Sealed / Non-Sealed)
S9	Mainline	Ch. 4+125 to Ch. 4+940	1.75	Watercourse	Non-Sealed
S10	Mainline	Ch. 4+940 to Ch. 5+640	2.19	Watercourse	Non-Sealed
S11	Mainline	Ch. 5+640 to Ch. 6+300	2.02	Existing Sewer	Non-Sealed
S12	Mainline	Ch. 6+300 to Ch. 7+300	3.15	Watercourse	Non-Sealed
S13	Mainline	Ch. 7+300 to Ch. 7+525	0.91	Watercourse	Non-Sealed
S14A	Mainline	Ch. 7+525 to Ch. 8+250	5.66	Existing Culvert	Non-Sealed
S14B	Mainline	Ch. 8+250 to Ch. 8+525	0.85	Watercourse	Non-Sealed
S18A	Mainline	Ch. 8+525 to Ch. 9+250	1.75	Watercourse	Sealed
S18B	Mainline	Ch. 9+250 to Ch. 10+150	2.27	Watercourse	Sealed
S19A	Mainline	Ch. 10+150 to Ch. 10+730	1.95	Infiltration Basin	Sealed
S19B	Mainline	Ch. 10+730 to Ch. 11+150	2.22	Infiltration Basin	Sealed
F19	Mainline	Ch. 11+150 to Ch. 11+420	N/A	Foul Sewer	Sealed
S20	Mainline	Ch. 11+420 to Ch. 12+020	4.95	Infiltration Basin	Sealed
S21B	Mainline	Ch. 12+020 to Ch. 13+630	8.28	Infiltration Basin	Sealed
S22A	Mainline	Ch. 13+360 to Ch. 14+350	5.68	Infiltration Basin	Sealed
S22B	Mainline	Ch. 14+350 to Ch. 14+950	3.06	Infiltration Basin	Sealed
F24	Mainline	Ch. 14+950 to Ch. 15+200	N/A	Foul Sewer	Sealed
S30	Mainline & Junction& Side Road	Ch. 15+200 to Ch. 15+700 Galway Racecourse Tunnel to Briarhill Coolagh Junction to Briarhill Tie-in Realigned	6.33	Existing Sewer	Sealed

Drainage Network Ref. No.	Mainline / Junction	Chainage	Approx. Total Drainage Area (ha)	Outfalling to	Drainage System Type (Sealed / Non-Sealed)
		Briarhill Business Park Road			
S26	Mainline	Ch. 15+750 to Ch. 16+750	5.12	Existing Sewer	Sealed
S27	Mainline	Ch. 16+750 to Ch. 17+535	5.47	Existing M6 Infiltration Basin	Sealed
S21A	Junction	Ch. 12+125 N84 Headford Road Junction	3.31	Attenuation Basin	Sealed
S22E	Junction	Ch. 14+400 N83 Tuam Road Junction (northern loop of junction and northern section of Parkmore Link Road)	0.79	Infiltration Basin	Sealed
S29	Junction	Ch. 16+500 Coolagh Junction south to tie-in with R446	2.73	Existing Sewer	Sealed

Suitably sized and located outfalls have been designed in accordance with DN-DNG-03071 – Design of Outfall and Culvert Details (HD 107).

Sub-Surface Drainage

A sub-surface drainage system of the road pavement will be provided in order to control groundwater levels in the vicinity of the proposed road development and to drain the road foundation. This is required in areas of cuttings and low embankments (<1.5m). In general, this is achieved using a network of filter drains or narrow filter drains.

Due to the karstic nature of the catchments to the east of the N59 Moycullen Road a hydrogeological risk assessment for each surface water drainage network catchment has been carried out at the location of each infiltration basin. This assessment is included in **Chapter 10, Hydrogeology**.

Structure Drainage

A separate isolated sealed drainage system will be utilised for the Lackagh Tunnel and the Galway Racecourse Tunnel structures. The drainage system will be designed in accordance DN-STR-03015 – Design of Road Tunnel (BD78). The sealed system of slot drains and carrier pipes will be used in both tunnels to pick up groundwater ingress, surface water from wheels, fire flows and tunnel wash down, all of which will be drained to sumps and pumped to the closest foul sewer. This system mitigates against the potential for pollution of groundwater and also minimises the risk to the Lough Corrib cSAC surface water bodies.

A watertight seal will be installed on the underside of the road base and cuttings on the western approach to the Lackagh Tunnel and on the eastern approach to the Galway Racecourse Tunnel up to the known high winter groundwater level. This is to protect against groundwater inflow and prevent contamination of groundwater and no dewatering is permitted in the operational phase of the proposed road development at these locations (see **Chapter 10, Hydrogeology**).

Drainage of the proposed bridge structures will be managed so as to achieve the requirements set out in DN-DNG-03022 – Drainage Systems for National Roads (HD33/15). For the long lengths of the Menlough Viaduct and the River Corrib Bridge a specialised sealed drainage system will capture the runoff on the bridge deck, transport it beneath the structure in a network of slung sealed carrier drains, before descending into the ground at suitable pier locations and discharging to a wetland and attenuation treatment area. This is required due to the sensitivity of the areas which the bridges are crossing above i.e. Limestone pavement and Turlough (Priority Annex 1 habitats) and the River Corrib (Lough Corrib cSAC).

Link Road and Side Road Drainage

The side roads and proposed link roads where drainage is proposed include the R336 Coast Road, L5386 Na Foraí Maola Road, L5387 Troscaigh Road, Na Foraí Maola to Troscaigh Link Road North, South and Overbridge Link, L1321 Bearna to Moycullen Road, L5384 Aille Road, Cappagh Road, Ballymoneen Road, Rahoon Road, Clybaun Road, L1323 Letteragh Road, N59 Link Road North and South, Seanbóthar, N84 Headford Road, L2134 School Road, N83 Tuam Road, Parkmore Link Road, Briarhill Business Park Road, Ballybrit Crescent and R339 Monivea Road. These roads require kerbs at locations including at bridge or junction locations or where footways are required and will therefore be drained using gullies with carrier drains or combined filter/carrier drains. Piped drains will discharge to an outfall, a sealed drain or to the mainline drainage system. **Table 5.10** summarises the proposed link road drainage networks.

Table 5.10: Summary of Link Road and Side Road Drainage Networks

Drainage Network Ref. No.	Link Road/Side Road	Road Name and Chainage	Approx. Total Drainage Area (ha)	Outfalling to	Drainage System Type (Sealed/Non-Sealed)
S4B	Link Road	Troscaigh Road	0.12	Watercourse	Non-Sealed
S15	Link Road	N59 Link Road North	1.89	Watercourse	Non-Sealed
S16A	Link Road	N59 Link Road North and South	4.16	Existing Sewer	Non-Sealed
S17A	Link Road	Letteragh Road - Ch. 1+625 to Ch. 2+210	1.08	Existing Sewer	Non-Sealed
S22C1	Link Road	City North Business Park Road - Ch. 14+400	1.46	Existing Sewer	Sealed
S22C2	Link Road	Parkmore Link Road - Ch. 14+400	0.55	Infiltration Basin	Sealed
S5B	Side Road	Upgrading of Bearna to Moycullen Road South - Ch. 2+800	0.24	Watercourse	Non-Sealed
S16B	Side Road	Letteragh Rd - Ch. 1+500	0.12	Existing Sewer	Non-Sealed
S17B	Side Road	Gort Na Bró Realignment - Ch. 2+210	0.34	Existing Sewer	Non-Sealed
S31A	Side Road	Upgrading of Letteragh Road - Ch. 7+275	0.09	Watercourse	Non-Sealed
S31B	Side Road	Upgrading of Letteragh Road - Ch. 7+275	0.15	Watercourse	Non-Sealed
S31C	Side Road	Upgrading of Letteragh Road - Ch. 7+275	0.25	Existing Sewer	Non-Sealed
S32	Side Road	Realigned Clybaun Road and Rahoon Road - Ch. 6+325	0.80	Existing Sewer	Non-Sealed

Drainage Network Ref. No.	Link Road/Side Road	Road Name and Chainage	Approx. Total Drainage Area (ha)	Outfalling to	Drainage System Type (Sealed/Non-Sealed)
S33	Side Road	Realigned Racecourse Avenue - Ch. 15+000	0.83	Existing Sewer	Sealed
S36A	Side Road	Realigned Aille Road North - Ch. 3+300	0.24	Watercourse	Non-Sealed
S36B	Side Road	Upgrading of Aille Road South - Ch. 3+300	0.10	Existing Ditch	Non-Sealed
S37	Side Road	Upgrading of Cappagh Road South - Ch. 4+450	0.21	Existing Sewer	Non-Sealed
S38	Side Road	Upgrading of Ballymoneen Road North - Ch. 5+650	0.14	Existing Sewer	Non-Sealed
S39	Side Road	Realigned entrance of Gateway Retail Park in Knocknacarra	0.22	Existing Sewer	Non-Sealed
S40	Side Road	Upgrading of Seanbóthar and access road - Ch. 10+500	0.16	Infiltration Basin	Sealed
S41	Side Road	School Road - Ch. 13+150	0.24	Existing Sewer	Sealed

Side roads that do not require kerbs will be drained using either over-the edge drainage or combined filter drains where appropriate in accordance with the principles described above. The drains will discharge to an outfall, a sealed drain or to the mainline drainage system.

Outfalls, Attenuation Ponds and Infiltration Basins

West of the N59 Moycullen Road the surface water collected by the carriageway drainage system will be discharged to watercourses crossed by, or adjacent to, the proposed road development. In order to prevent discharge from the road increasing the peak flow rate of water within many of the watercourses, which may compound any flooding downstream of the proposed road development, flow restriction and attenuation storage is proposed. Attenuation ponds have been selected as the main attenuation facility provided along the proposed road development. Attenuation ponds will not be lined to the west of the N59 Moycullen Road and can become a feature of the landscape in time and is in line with current best practice guidelines. The proposed outfalls, with proposed attenuation ponds, have been chosen at appropriate locations along the route of the proposed road development typically as close as possible to an existing watercourse. **Table 5.11** details the drainage networks that discharge to watercourses and the associated volumes of storage required to attenuate peak flows up to the 1 in 100 year return period storm event.

Table 5.11: Proposed Mainline and Link Road Drainage Networks Discharging to Surface Waterbodies

Drainage Network Ref. No.	Approx. Total Drainage Area (ha)	Approx. Pavement Area (ha)	Approx. Attenuation Pond - Volume of Storage (m^3)	Network Discharge Q100 (l/s)
S1	2.05	1.29	894	8.4
S2	0.55	0.38	184	5.0
S3	2.31	1.28	1028	8.7
S4A	0.96	0.62	324	5.2
S5A	2.45	1.53	977	9.7
S7A	0.30	0.24	81	4.8
S7B	2.94	1.07	1081	11.5
S8	0.42	0.26	114	4.7
S9	1.75	1.19	796	8.2
S10	2.19	1.22	873	8.3
S12	3.15	2.45	1697	11.5
S13	0.91	0.63	378	5.0
S14A	5.66	2.20	1975	21.0
S14B	0.85	0.65	613	5.2
S18A	1.75	1.58	N/A	427.7
S18B	2.27	1.95	N/A	494.8
S21A	3.31	1.36	1568	5.2

Drainage Network Ref. No.	Approx. Total Drainage Area (ha)	Approx. Pavement Area (ha)	Approx. Attenuation Pond - Volume of Storage (m^3)	Network Discharge Q100 (l/s)
S4B	0.12	0.07	21	4.2
S15	1.89	0.73	692	7.5

Where the drainage system outfalls to a watercourse the final outfall level (after the attenuation and treatment measures) shall be set above the 1 in 5 year flood level of the watercourse where possible. Furthermore, an assessment of the impact of the outfall from the pond on the hydraulic regime of the watercourse has been undertaken (**Chapter 11, Hydrology**).

A flow control device (Hydro-Break or similar) will be installed at the outfall location of all attenuation ponds to restrict the flow rate from the pond to the receiving watercourse. The discharge rate for each drainage catchment is set to the Q_{bar} greenfield runoff rate to replicate the existing environment or to a minimum of 5 l/s to minimise the risk of blockage from debris within the network.

There are a number of outfalls to existing sewers along the proposed road development. The surface water sewers are generally located in the more urbanised areas adjacent to the proposed road development, where existing streams and ditches have already been previously culverted to facilitate development. **Table 5.12** details the drainage networks that discharge to existing storm sewers.

Table 5.12: Proposed Mainline & Link Road Drainage Networks Discharging to Storm Sewers

Drainage Network Ref. No.	Approx. Total Drainage Area (ha)	Approx. Pavement Area (ha)	Network Discharge Q100 (l/s)	Receiving Storm Sewer Diameter (mm)
S11	2.02	1.57	7.8	300
S26	5.12	3.47	4.5	900
S29	2.73	2.07	5.0	900
S30	6.33	4.58	5.7	900
S16A	4.16	2.15	16.1	450
S17A	1.08	0.98	5.7	1500
S22C1	1.46	1.36	5.0	900

To the east of the N59 Moycullen Road the surface water collected by the carriageway drainage system will be discharged to ground via an infiltration basin where a positive outfall to a watercourse is not available. Ground investigations have been undertaken at the proposed locations of the infiltration basins to determine the permeability of the existing soil and bedrock and inform the design of the infiltration basins. Where the infiltration rate is outside the range of the permissible flow rates (e.g. discharge directly to karst limestone bedrock) then the base layer of the infiltration basin will be created synthetically to reduce the infiltration rate artificially. The design infiltration rate for the proposed road development is 0.036m/hr. The infiltration basins have been sized so as to drain down to half volume in a 24-hour period. The infiltration basins will not be lined so as to allow for infiltration to ground. **Table 5.13** details the proposed drainage networks that discharge to ground via infiltration basin.

Table 5.13: Proposed Mainline and Link Road Drainage Networks Discharging to Ground via Infiltration Basins

Drainage Network Ref. No.	Approx. Total Drainage Area (ha)	Approx. Pavement Area (ha)	Infiltration Basin - Volume of Storage (m^3)	Approx. Invert Level (mAOD)
S19A	1.95	1.66	1226	11.15
S19B	2.22	1.68	1112	10.24
S20	4.95	2.23	1928	14.74
S21B	8.28	4.82	4227	18.53
S22A	5.68	3.94	2953	14.07
S22B	3.06	2.76	2543	37.93
S27	5.47	N/A	N/A	N/A
S22E	0.79	0.69	300	45.71
S22C2	0.55	0.52	290	38.64

To the East of the N59 Moycullen Road, where attenuation ponds and discharge to watercourses or public sewers are proposed in the karst limestone area, the base of the attenuation ponds will be lined to prevent infiltration to groundwater using a synthetic or suitable clay liner.

All attenuation ponds and infiltration basins will cater for return period up to a 1 in 100 year storm event minimising any increase in flood risk to adjacent properties as set out in Clause 7.5 of DN-DNG-03022 (HD33/15). A minimum freeboard of 300mm is provided between the maximum water level in the attenuation pond or infiltration basin and the top level of the pond/basin or the pond/basin protection bund. Peak discharge rates from the proposed road development will not exceed the peak discharge rates in the greenfield scenario for the critical storm return period. The pond/basin will be bunded to a level 500mm above any adjacent 1 in 100 year flood levels in rivers or streams. To reduce the risk of receiving water and groundwater being contaminated by runoff from the proposed road development, pollution control measures will be provided as detailed in the following section.

Pollution Control

Pollution control measures are proposed prior to each outfall/discharge point from the carriageway to reduce the risk of watercourses or groundwater being contaminated by runoff from the proposed road development. A range of pollution control measures have been adopted along the length of the proposed road development which includes combined filter drains, attenuation ponds, grassed surface water channels, petrol and oil interceptors, emergency spill containment areas, surface flow wetlands and infiltration basins.

Sustainable drainage systems (SuDS) have been considered in the first instance. Only where there is insufficient space or the road geometry precludes their inclusion (e.g. on embankments higher than 1.5m or in cuttings with groundwater drainage problems) were other conventional methods used. In general, where the risk to groundwater is low combined filter drains form the first treatment against pollutants making their way into surrounding water bodies as combined filter drains can reduce the release of pollutants. The filter material will trap suspended solids and other contaminants thus reducing the downstream pollution risk. Where the proposed road development carriageway runoff will drain into grassed surface water channels, the slow moving flow through the wide shallow grassed channels will allow for the processes of sedimentation and adsorption to take place while carrying the runoff to the outfall.

Where the groundwater is highly vulnerable, typically in the karstic area to the east of the River Corrib, a sealed drainage system will collect and distribute surface water runoff to a suitable outfall location/discharge point (e.g. carrier pipe with gullies, concrete surface water channels, slot drains etc.) Sub surface flow will be collected in a series of narrow filter drains.

At each mainline and link road drainage network across the proposed road development, a SuDS surface flow (SF) treatment wetland will also be provided upstream of each attenuation pond or infiltration basin to further treat runoff. The surface flow wetlands have been sized to store the 'First Flush' runoff from their associated road pavement catchments in the permanent pool. This comprises a volume equal to a 15mm depth of rainfall on the road catchment. This 'First Flush' runoff carries the highest load of pollutants, compared to runoff discharged later in the rainfall event. The minimum depth of the permanent pool is 600mm which will further encourage settlement of suspended solids and will be lined to reduce the risk of watercourses or groundwater being contaminated by runoff from the proposed road development. Suitable planting and additional measures will be employed to encourage the settlement of silt and absorption of any remaining pollutants i.e. silt traps, reed beds. The increased retention time provided by the wetland will provide additional time for further adsorption and sedimentation to take place and will also allow for a range of natural biological processes (including biodegradation, microbial action and plant uptake) to further remove waterborne pollutants.

Oil and petrol interceptors will be provided upstream of the wetland and attenuation pond/infiltration basin to prevent any contamination from hydrocarbons, such as oil or petrol spillages, from entering the receiving water or groundwater. The interceptors will be sized for each drainage catchment according to the inflow. Along the mainline of the proposed road development a minimum emergency spill containment volume area equal to $25m^3$ will be provided at all outfall locations as set out in the TII Drainage Standards.

The outfalls of each drainage network have been assessed individually for potential impacts to the water environment as part of the HD45 assessments and appropriate methods of treatment applied in accordance with TII requirements, the assessments are detailed in the **Chapter 10, Hydrogeology** and **Chapter 11, Hydrology**. The adopted pollution control measures are listed in **Table 5.14**.

Table 5.14: Proposed Pollution Control Measures for Mainline, Link Road and Side Road Drainage Networks

Drainage Network Ref. No.	Discharging to	Pollution Control Measure
S1	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S2	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S3	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S4A	Watercourse	Spillage Containment Area, Oil and Petrol interceptor, Wetland, Attenuation Pond
S5A	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S7A	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S7B	Watercourse	Spillage containment Area, Oil and Petrol interceptor, Wetland, Attenuation Pond
S8	Watercourse	Spillage containment Area, Oil and Petrol interceptor, Wetland, Attenuation Pond
S9	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S10	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S11	Existing Sewer	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S12	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S13	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S14A	Existing Culvert	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S14B	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S18A	Watercourse	Spillage Containment Pipes, Oil and Petrol Interceptor, Wetland
S18B	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland
S19A	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
S19B	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
F19	Foul Sewer	Spillage Containment Area, Oil and Petrol Interceptor discharging to Foul Sewer. Discharge to be treated at Mutton Island Waste Water Treatment Works

Drainage Network Ref. No.	Discharging to	Pollution Control Measure
S20	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
S21B	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
S22A	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
S22B	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
F24	Foul Sewer	Spillage Containment Area, Oil and Petrol Interceptor discharging to Foul Sewer. Discharge to be treated at Mutton Island Waste Water Treatment Works.
S26	Existing Sewer	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S27	Existing M6 Infiltration Basin	Existing M6 Infiltration Pond
S21A	Attenuation Basin	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S22E	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
S29	Existing Sewer	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S30	Existing Sewer	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S4B	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S15	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S16A	Existing Sewer	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S17A	Existing Sewer	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S22C1	Existing Sewer	Spillage Containment Pipe, Oil and Petrol Interceptor, Attenuation Pond
S22C2	Infiltration Basin	Spillage Containment Pipe, Oil and Petrol Interceptor, Infiltration Basin
S5B	Watercourse	None Required, overlay of existing local road
S16B	Existing Sewer	Online Attenuation - Flow Control and Oversized Pipes
S17B	Existing Sewer	Online Attenuation - Flow Control and Oversized Pipes
S31A	Watercourse	None Required, overlay of existing local road
S31B	Watercourse	None Required, overlay of existing local road
S31C	Existing Sewer	Online Attenuation - Flow Control and Oversized Pipes
S32	Existing Sewer	Attenuation Pond

Drainage Network Ref. No.	Discharging to	Pollution Control Measure
S33	Existing Sewer	Attenuation Tank
S36A	Watercourse	None Required, upgrade of existing local road
S36B	Existing Ditch	None Required, overlay of existing local road
S37	Existing Sewer	Online Attenuation - Oversized Pipes
S38	Existing Sewer	None Required, overlay of existing local road
S39	Existing Sewer	None Required, overlay of existing local road
S40	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Infiltration Basin
S41	Existing Sewer	None Required, overlay of existing local road

The regular inspection and maintenance of drainage systems is essential for continued protection of the natural water regime into which the road runoff discharges and must take priority. Maintenance procedures are to be undertaken as set out in TII Publications, guidance documents and best practice methods.

5.5.4.9 Utilities

The infrastructure of a number of service providers is impacted by the proposed road development. The provision of the proposed road development shall ensure there are no permanent disruptions to services provided by these bodies and that all temporary disruptions must be kept to a minimum. Where services diversions are required all design works and construction works must be carried out in coordination with the relevant statutory bodies and services providers.

Furthermore, these services are being developed and expanded on an on-going basis. In order to avoid trenching in the new road for services after completion, provision must be made at construction stage for future crossing by services where agreed with local authority.

The following statutory bodies and service providers were consulted to identify conflict areas between their services and the proposed road development:

- Galway County Council – Watermain, Surface Water Drainage, Foul Sewer
- Galway City Council – Watermain Surface Water Drainage, Foul Sewer
- Irish Water – Watermain, Foul Sewer
- Eir
- ESB Networks – Low to Medium Voltage
- ESB Networks as the Transmission system Owner and EirGrid as the Transmission System Operator ESB International (ESBI), – High Voltage
- Gas Network Ireland – Transmission and Distribution
- E-Net
- Virgin Media

- BT Ireland
- SSE Airtricity
- Three Networks Ireland

All works required for the diversion or protection of any of the above services in conflict with the proposed road development have been confirmed with each of the service providers. Further details on the locations, potential utility impacts and proposed measures are included in **Chapter 15, Material Assets Non-Agriculture**.

5.5.4.10 Noise Barriers

The aspects relating to noise barriers are discussed in **Chapter 17, Noise and Vibration**.

5.5.4.11 Biodiversity measures

Four new artificial bat roosts and the modification of one existing building to become a bat roost are proposed as part of the proposed road development. Full details of these roosts are discussed in **Chapter 8, Biodiversity**.

5.5.4.12 Permanent Maintenance Facilities

There are two permanent maintenance facilities proposed as part of the proposed road development. These tunnel services, monitoring and maintenance buildings (TSB) will house operations personal and tunnel plant and equipment and will include an office area, control room, technical equipment room(s) (TER(s)), staff welfare facilities, stores and plant rooms to assist with the monitoring and control of traffic and systems both leading up to and within the tunnel.

Both are located in close proximity to the proposed tunnel structures. These permanent maintenance facilities will serve as tunnel services, monitoring and maintenance buildings. One facility is located in Lackagh Quarry on the south side of the eastern portal of Lackagh Tunnel and the other is located at Galway Racecourse adjacent to the western portal of the Galway Racecourse Tunnel as shown on **Figure 5.1.8** and **5.1.10** respectively.

These buildings will be serviced with electrical services, surface water drainage, potable water supply and foul water drainage. Heating, ventilation and air conditioning will be required to the TSB.

The surface water drainage design for the Lackagh TSB and Galway Racecourse Tunnel TSB site compounds are designed in accordance with best practice and BS EN-752 – Drain and Sewer Systems outside buildings. Roof runoff is collected from the rainwater down pipes and discharged to a system of carrier pipes located within the site compound. Runoff from the service yard and car parking areas will be collected using road gullies. Discharge from the service yard area will be routed through a Class 1 full retention forecourt oil and petrol interceptor located within the TSB site compound. The outfall discharge from the Lackagh TSB site is to ground via an infiltration basin which is provided as part of the mainline road drainage system. The outfall discharge from the Galway Racecourse Tunnel TSB site is to the existing trunk storm sewer located to the north of the eastern Racecourse Tunnel portal. The flow will be attenuated in an underground attenuation tank and released at a design discharge flow of 5l/s.

The water demand for the potable water supply is based on 10 staff per building with an assumed usage of 60 litres per person per day. The water connections will

also be utilised as needed to fill the tunnel fire water storage tanks. A pre connection enquiry form has been approved in principle by Irish Water for the connection to the existing public watermains. The watermain connection for the Lackagh Tunnel TSB is to the existing 150mm diameter public watermain located in Coolough Road. The proposed new watermain connection for the Racecourse Tunnel TSB is to the proposed new 100mm watermain diversion, located in the realigned racecourse avenue.

Pre-Connection Enquiries have been approved in principle by Irish Water for the proposed foul connections required for the TSBs. The foul wastewater discharge for the Lackagh Quarry TSB will be pumped to the public foul sewer at the Barr na Coille (Crestwood) housing estate adjacent to the Coolough Road. The foul wastewater discharge for the Galway Racecourse Tunnel TSB will be by gravity to the realigned IDA foul sewer west of the eastern Galway Racecourse Tunnel portal.

The main access for Lackagh Quarry TSB will be from the existing main entrance of Lackagh Quarry on Coolough Road. The main access to the Racecourse Tunnel TSB will be from the realigned Racecourse Avenue. Emergency access is also provided from the proposed road development to both buildings. Car parking will also be provided at both sites.

Drawings of the details on these tunnel services, monitoring and maintenance buildings are included in **Appendix A.5.1**.

5.5.4.13 Land and Property Requirements

Galway County Council, together with Arup, undertook a series of meetings with affected landowners.

The findings of these meetings have been combined with land registry records to produce a comprehensive landownership mosaic for the proposed road development (ref **Figures 14.01** to **14.15**).

This landownership mosaic together with information gained during individual meetings was used to establish access requirements and to evaluate side road and mainline realignments. Requests made by the impacted landowners and the general public were evaluated and included to the extent that this was reasonably possible having regard to the objectives of the proposed road development.

The accommodation works proposed will be introduced to serve the landowners in the following ways:

- To ensure landowners are given access to the local road network in the area, and that access can be gained between the local road and primary road networks
- To provide access between severed and separated land parcels

The accommodation works include access roads to allow access to land severed by the proposed road development. These access roads are 4.0m wide with 1.0m grass verges on either side and shall be designed in accordance with TII Standard Construction Details (SCDs) CC-SCD-02754 and CC-SCD-00706.

The following is a list of access roads identified. These access roads will be private roads with a private right of way provided to those parties listed in the **Table 5.15** below under the reference number.

Table 5.15: Access Roads

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
Ch. 0+000	80m access road AR0/01	102, 103	Provides access to houses and land parcels both via single field gates as current access is onto the existing R336
Ch. 0+000 to Ch. 0+250	320m access road AR0/02	106, 107, 108, 109, 112	Provides access to attenuation ponds and land parcels via single field gates as current access is severed by the proposed road development
Ch. 0+650 to Ch. 0+700	65m access road AR0/03	-	Provides access to attenuation ponds.
Ch. 0+850 to Ch. 0+950	160m access road AR0/04	114, 117	Provides access to land parcels
Ch. 0+990	30m access road AR0/05	-	Provides access to attenuation ponds only
Ch. 1+100 (Troscaigh Road L5387)	35m access road AR1/01	130, 131, 7891	Re-graded entrance to a house and land parcels as current access via Foraí Maola Road is severed by the proposed road development
Ch. 1+300 (Troscaigh Road L5387)	30m access road AR1/03	144, 145	Provides access (via the proposed Na Foraí Maola to Troscaigh link road) to land parcels as current access arrangement is impacted by the proposed road development
Ch. 1+500	15m access road AR1/04	156, 157	Proposed access to tie-in to existing access to houses. Current access arrangement via Troscaigh Road L5387 is impacted by the proposed road development
Ch. 1+550	25m access road AR1/05	154	Provides access to land parcel as current access arrangement via Troscaigh Road L5387 is severed by the proposed road development
Ch. 1+550 to Ch. 1+675 (Troscaigh Road L5387)	215m access road AR1/06	149, 150, 151, 152, 153	Access to houses and land parcels but also provides access to attenuation ponds

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
Ch. 1+750 to Ch. 2+550	830m access road AR2/02	197, 171, 147, 174, 173, 172, 170, 169, 167, 166, 146, 165,	Provides access to houses and land parcels as current access via Ann Gibbons Road L13215 is severed by the proposed road development
Ch. 2+475 to Ch. 2+550	65m access road AR2/01	176	Provides access to land parcel via Ann Gibbons Road L13215 as land parcel is being severed by proposed development
Ch. 3+275	10m access road AR3/01	199	Provides access to land as current access via Aille road is altered by the proposed road development (located north of proposed Aille Overbridge S03/01)
Ch. 3+325 to Ch. 3+900	620m access road AR3/02	197, 205, 208, 209, 210	Provides access to land parcels via Aille Road L5384 as current access is severed by the proposed road development. Also provides access to attenuation ponds
Ch. 4+025 to Ch. 4+050	75m access road AR4/01	-	Provides access to attenuation ponds
Ch. 4+240 to Ch. 4+360	140m access road AR4/02	-	Provides access to attenuation ponds
Ch. 4+450 (South of Cappagh Road Junction)	20m access road AR4/03	213	Access re-alignment required due to the proximity with the proposed Cappagh Road signalised Junction
Ch. 4+450 (North of Cappagh Road Junction)	10m access road AR4/04	215	Access re-alignment required due to the proximity with the proposed Cappagh Road signalised Junction
Ch. 4+450 to Ch. 4+675 (North of Cappagh Road Junction)	185m access road AR4/05	216, 223, 226	Provides access onto land parcels as current access via Boleybeg Bóthrín is severed by the proposed road development
Ch. 4+525 to Ch. 4+650	145m access road AR4/06	223, 224, 226, 227	Re-alignment of Boleybeg Bóthrín as currently being severed by the proposed road development. Provides access onto land parcels

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	**Description**		
Ch. 4+950 to Ch. 4+990	60m access road AR4/07	-	Provide access to attenuation ponds. Pond access gate to be provided
Ch. 5+360 to Ch. 5+660 North of Ballymoneen Road Junction	345m access road AR5/01	223, 232, 230	Provide access to farmyard and land parcels as current access is directly onto the existing Ballymoneen Road
Ch. 5+600 to Ch. 5+625 South of Ballymoneen Road Junction	30m access road AR5/02	232	Access already provided to houses located directly onto Ballymoneen Road, but re-alignment needed due to the proximity with the proposed signalised Junction
Ch. 6+375 to Ch. 6+475	110m access road AR6/01	243	Provide access to land parcel as existing access via Clybaun Road is severed by the proposed road development
Ch. 6+525 to Ch. 6+560	45m access road AR6/02	312	Provides access to farmyard. Access provided as part of Clybaun Road re-alignment
Ch. 6+600 to Ch. 6+960	370m access road AR6/03	241, 239, 247	Provide access to land parcels as being severed by the proposed road development
Gort na Bró Link Road	25m access road AR6/06	479	Access provided to tie the proposed road development in to the existing access road which eventually provides access to Gateway Retail Park
Gort na Bró road	100m Gateway Retail Park Link Road AR6/04	-	Realignment of access to Gateway Retail Park Link Road including roundabout
Gort na Bró road	30m access road AR6/05	-	Access provided to tie the proposed road development in to the existing access road to Gort na Bró housing estate
Gort na Bró road - North	15m access road AR6/06	-	Provides access to Gateway Retail Park
N59 Link Road South Ch. 1+900	50m access road AR7/01	481	Provides access to land parcels as part of the proposed road development
N59 Link Road South Ch. 1+900	60m access road AR7/02	-	Provides access to Bun a’ Chnoc and Culgharraí housing developments as part of the proposed road development
N59 Link Road South Ch. 1+900	55m access road AR7/03	-	Provides access to Bun a’ Chnoc and Culgharraí housing developments as part of the proposed road development. Ties-in to AR7/02
Ch. 7+225 to Ch. 7+300	60m access road AR7/04	250	Located just off Letteragh Road L1323. Provides access to land parcel as current access is severed by the proposed road development

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	**Description**		
Ch. 7+260 to Ch. 7+450	200m access road AR7/05	272	Located just off Letteragh Road L1323. Provides access to land parcel as current access is severed by the proposed road development. Also access to attenuation ponds
N59 Link Road South Ch. 1+500	60m access road AR7/06	486	Located just off Letteragh Road L1323, near the at-grade Letteragh Road junction. Provides access to house as current access is impacted by the provision of the junction
N59 Link Road South Ch. 1+350 to Ch. 1+400	80m access road AR7/07	486, 272	Provide access to land parcels as current access is severed by the proposed road development
N59 Link Road South Ch. 1+140 to Ch. 1+190	70m access road AR7/08	289	Provides access to house as current access is provided via a private access road
N59 Link Road Ch. 0+700 to Ch. 0+860	210m access road AR7/09	289, 502, 505, 501	Provides access to land parcels as current access is severed by the proposed road development
Ch. 7+800 to Ch. 7+850. Access from local road network	160m access road AR7/10	506 504	Provides access to land parcel as current access is severed by the proposed road development. Access via The Heath housing development
N59 Link Road South Ch. 1+760	10m access road AR7/11	484	Provides access to land parcel as current access is severed by the proposed road development
Ch. 8+360 to Ch. 8+500	115m access road AR8/01	518, 517	Located just off the N59. Provides access to house and ties-in to existing housing development access (517). Current access is severed by the proposed road development. Also provides access to attenuation ponds
Ch. 8+375 to Ch. 8+450	165m access road AR8/02	515	Provides access to house as current access is severed by the proposed road development. Access connected to Circular Road L1020
Ch. 8+525 to Ch. 8+625	115m access road AR8/03	-	Located just off the N59. Provides access to Aughnacurra Estate (houses and land parcels) as current access is severed by the proposed road development. Access is to tie-in with the remainder of the existing access
Ch. 8+450	30m access road AR08/04	-	Located just off the N59 (northern part of the proposed road development). Ties-in to existing access road
Ch. 8+500	640m access road AR8/05	-	Provides access to attenuation ponds

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
Ch. 9+090 to Ch. 9+160	110m access road AR9/01	-	Provides access to NUIG Sporting Campus as current access is severed by the proposed road development. Also provides access to an attenuation pond located near-by
Ch. 9+710	120m access road AR9/02	559, 553	Underbridge that maintains and provides a link to land parcels to the south of Menlo Castle Bóithrín severed by the proposed road development. Also provides access to AR9/03 & AR9/04
Ch. 9+560 to Ch. 9+710	145m access road AR9/03	-	Provides access to attenuation ponds. Accessed from AR9/02
Ch. 9+710 to Ch. 9+850	160m access road AR9/04	565	Provides access to land parcel as current access is severed by the proposed road development. Accessed from AR9/02
Ch. 9+550	120m access road AR9/05	-	Provides access to land parcel as current access is severed by the proposed road development
Ch. 9+500	120m access road AR9/06	549	Provides access to land parcel as current access is severed by the proposed road development
Ch. 10+050 to Ch. 10+140	85m access road AR10/01	563, 568, 564	Located off Bóthar Nua, provides access to land parcels as current access is severed by the proposed road development
Ch. 10+475 to Ch. 10+890	420m access road AR10/02	581	Provides access to land parcels as current access is severed by the proposed road development; but also provides access to attenuation ponds - via AR10/03, AR10/04, AR10/05, AR10/06, or AR10/07
Ch. 10+625	100m access road AR10/03	563	Provides access to land parcel as current access is severed by the proposed road development. Also provides access to attenuation pond. Ties-in to AR10/02 & AR10/04
Ch. 10+625 to Ch. 10+670	65m access road AR10/04	553	Provides access to land. Ties-in to AR 10/03 & AR10/05
Ch. 10+625 to Ch. 10+725	125m access road AR10/05	-	Ties-in to AR 10/02 and AR 10/03. Loop around attenuation pond to allow the Over Height Vehicles coming from the emergency slip road (prior the Lackagh tunnel) exit the AR network
Ch. 10+825	20m access road AR10/06	-	Allow for turning movement of the Over Height Vehicles coming from the emergency slip road (prior the Lackagh tunnel) exit the AR network. Access road accessed from AR10/02
Ch. 10+620 to Ch. 10+700	70m access road AR10/07	-	Provides the last exit point for Over Height Vehicles travelling east-bound on the N6 GCRR before to enter the Lackagh tunnel. Connects to AR10/02
Ch. 11+075 to Ch. 11+575	615m access road AR11/01	-	Provides re-routing for Over Height Vehicles engaged on the N6 GCRR prior entering the Lackagh Tunnel when travelling west-bound.

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
			Also provides access to attenuation ponds, and Tunnel services building
Ch. 11+990 to Ch. 12+125	245m access road AR11/02	583, 603	Provides access to farmyards and land parcels along the existing Ballindooley Bóithrín as current access is severed by the proposed road development
Ch. 12+110 to Ch. 12+240	130m access road AR12/01	602	Provides access to commercial premises. Slight Re-alignment of the existing access as located in close proximity with the proposed N84 grade separated junction
Ch. 12+290 to Ch. 13+090	100m access road AR12/03	602	Provides access to land parcel of the commercial premises. Work required to realign existing access as it is located in close proximity with a proposed retaining wall
Ch. 12+540 to Ch. 13+100	630m access road AR12/04	626, 627	Provides access to land parcels via School Road, as current access is severed by the proposed road development. Also provides access to attenuation ponds. Maintains access to the northern portion of Hynes' Bóithrín
Ch. 13+140 to Ch. 13+180	70m access road AR13/01	631, 635, 7103	Re-alignment of the existing Spellman's Bóithrín access road due to the close proximity with the Overbridge S13/01. Provides access to houses and land parcels via School Road
Ch. 13+140 to Ch. 13+290	180m access road AR13/02	625, 651, 627	Provides access via School Road to land parcels as current access is severed by the proposed road development
Ch. 13+390 to Ch. 13+425	45m access road AR13/03	625, 658	Provides access to land parcels as current access is severed by the proposed road development. Located on an existing access road that connects with School Road
City North Business Park Link	145m access road AR13/04	690,	Provides access to City North Business Park commercial premises as existing access (from the N83 Tuam Road) is severed by the proposed road development. Access to be re-located onto the proposed City North Park Link. Also provides access to attenuation ponds
Ch. 13+725 (Off the N83 Tuam Road)	25m access road AR13/05	-	Provides access to attenuation ponds
Ch. 13+825 to Ch. 14+175 (Off the N83 Tuam Road)	470m access road AR13/06	683, 682, 681, 680, 679, 678, 677, 676,	Provides a new access to individual houses and land parcels which are currently accessed directly from the N83 Tuam Road. Access road will be segregated from N83 Tuam Road

Location		**Plot ID / Landowner Reference**	**Comments**
Approx. Chainage	**Description**		
		675, 674, 673, 658,	
Parkmore Link Road	50m access road AR13/07	695, 696	Re-alignment of the existing access to commercial premises (Ballybrit Business Park) so as to accommodate the proposed Parkmore Link Road
Parkmore Link Road	35m access road AR13/08	695	Re-alignment of the existing access to commercial premises (Ballybrit Business Park) so as to accommodate the proposed Parkmore Link Road
Parkmore Link Road	50m access road AR13/09	695	Re-alignment of the existing access to commercial premises (Ballybrit Business Park) so as to accommodate the proposed Parkmore Link Road
Parkmore Link Road	20m access road AR14/04	701	Provides access to land parcel as current access is severed by the proposed road development
Parkmore Link Road	45m access road AR14/05	696	Connects the proposed Parkmore Link Road with the existing Parkmore Industrial Estate internal road
Parkmore Link Road	75m access road AR14/07	691	Provides access to Galway Racecourse
Parkmore Link Road	20m access road AR14/08	691	Provides access to Galway Racecourse
Ch. 14+790 to Ch. 15+000	235m access road AR14/09	-	Provides the last exit point for Over Height Vehicles travelling east-bound on the proposed road development before to enter the Galway Racecourse Tunnel. Connects to AR15/01
Ch. 15+125	470m access road AR15/01	691, 707, 713	Re-alignment of the Racecourse Avenue which provides access to commercial premises, as current access is severed by the proposed road development. Also provides access to proposed Galway Racecourse Tunnel services building. Ties-in to AR14/09 but also AR 15/06
Ch. 15+200 to Ch. 15+725	545m access road AR15/02	691, 716, 701, 718, 719	Provides access to land parcels as current access is severed by the proposed road development. Also provides access to attenuation ponds. Ties-in to AR15/03 to the south, and to AR15/06 to the north; also provides access to AR15/07 users (Over Height Vehicle re-routing option)
Ch. 15+700 to Ch. 15+725	185m access road AR15/03	719, 721, 733	Provides access to Briarhill Business Park commercial premises (from Parkmore Road) as current access is severed by the proposed road development. The access road is proposed to pass

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
			under S15/02 bridge. Provides access to AR15/04 and to AR15/02
Ch. 15+690 to Ch. 15+720	30 m access road AR15/04	720, 719	Slight re-alignment of the current access to a commercial premise (from proposed AR 15/03) as it is in close proximity with the proposed S15/02 Underbridge
City East Business Park Junction	55m access road AR15/05	691	Re-alignment of the existing access road to the Galway Racecourse as part of the near-by junction's upgrade
Ch. 15+150 to Ch. 15+200	120m access road AR15/06	-	Provides connection (over the Galway Racecourse Tunnel) to AR15/01 and AR15/02 to facilitate the re-routing of Over Height Vehicles
Ch. 15+425 to Ch. 15+475	50m access road AR15/07	-	Provides re-routing for Over Height Vehicles engaged on the proposed road development prior entering the Galway Racecourse Tunnel when travelling west bound. Connects to AR15/02
Briarhill Link	55m access road AR16/01	724	Provides access to land parcel as current access is severed by the proposed road development
Ch. 16+800 to Ch. 16+830	30m access road AR16/02	756, 757	Upgrade/slight re-alignment of an existing access road to serve land parcel severed by proposed development boundary
Ch. 16+950 to Ch. 17+475	560m access road AR17/01	754, 753, 752	Provides access to land parcels as current access is severed by the proposed road development. Connects to existing access road

Alternative pitch facilities will be provided at NUIG to replace the existing pitches directly impacted by the proposed road development. The facilities include a floodlit 3G GAA pitch and a floodlit 3G training area and associated site infrastructure for the drainage of these pitches and furniture such as ball-stop netting. The proposed road development also intercepts the existing sports pavilion resulting in direct impacts to its western end and the building will be modified as follows:

- the existing western plant room, 1 no. changing room, 1 no. storage area, 1 no. weights area and associated access hallways on both ground floor and upper levels will be demolished
- the western plant room and its associated plant will be relocated
- Construction and reconfiguration of the internal and external walls, roof, windows and door locations

Refer also to **Chapter 15, Material Assets Non-Agriculture** and **Appendix A.15.1**.

Temporary stables will be provided for Galway Racecourse during the construction of the proposed road development until such time as the Galway Racecourse Tunnel is complete and the permanent stables are constructed. This is further discussed in **Chapter 15, Material Assets Non-Agriculture** and **Appendix A.15.2**.

5.5.4.14 Demolitions and Acquisitions

One of the project objectives for the proposed road development was "to seek to preserve existing well established communities". Therefore, from the outset of the design of the proposed road development every effort was made to avoid property demolitions where possible. However, there are still unfortunately and unavoidably a number of property demolitions that are necessary for the construction of the proposed road development and to secure the many benefits the proposed road development offers as follows:

- 44 residential properties
- 2 industrial properties (one property includes four buildings)
- 2 commercial properties

In addition to the demolition of 44 residential properties, an additional 10 residential properties require full acquisition.

In addition to the demolition of 44 residential properties, an additional 10 residential properties, one commercial property and one landholding that has a full residential planning permission require full acquisition.

It is proposed that 17 farm buildings will be acquired to accommodate the proposed road development.

These properties and structures are also discussed in more detail in the following chapters of the EIAR:

- Chapter 12, Landscape and Visual
- Chapter 13, Architectural Heritage
- Chapter 14, Material Assets Agriculture
- Chapter 15, Material Assets Non-Agriculture
- Chapter 18, Human Beings, Population and Health

5.5.4.15 Planning Permission Modifications

The proposed road development will require the acquisition of lands from five properties upon which there is currently full planning permission for residential development or commercial development. These acquisitions will result in either the revocation or the need for modification of the planning permission. These properties are listed below in **Table 5.16** and set out in the Seventh Schedule of the Protected Road Scheme and Motorway Scheme.

Table 5.16: Non-Agricultural Planning Permissions affected by the proposed road development

PRS / MS Ref. Number	Townland	Description	Area of Property (Ha)	Description of Landtake/ Modification	Land to be Acquired (ha)
124	Na Foraí Maola	House and garden	0.47	Acquisition of whole site	0.47
149	Troscaigh Thiar	Planning permission for roadside boundary wall and existing access point as constructed with all associated works and ancillary services.	0.20	Boundary Wall relocation, Road Bed acquisition	0.01
229	Ballyburke	Planning permission granted for the demolition of two existing houses shed and outbuildings, construction of crèche, 3 no retail units, 3 no office units, bar/restaurant and 299 residential units in varying design and form, in two and three storey blocks, bin storage, ESB substation, surface and basement car parking and all associated external and site development works including 3 vehicular access points and road widening along Ballymoneen Rd. (1454) (Extension of time to 18/07/2019)	9.2	Severance of site	1.45
528_543	Dangan Lower	Permission for new all-weather sports pitch on the site of existing training pitch (including floodlighting)(14104)	95.896	Partial acquisition of property	6.293
528_543	Dangan Lower	Permission for flood lighting of existing GAA pitches adjacent to the river. (17159)	95.896	Partial acquisition of property	6.293

5.6 Functionality of N6 GCRR

The function of the N6 GCRR is to facilitate the reduction of existing traffic congestion and future proof the effectiveness of this part of the national road network. To achieve this dual functionality, the proposed road development design sought to:

1. provide for the strategic need of the TEN-T comprehensive road network and connectivity of Galway City and the West Region to the national road network
2. provide an additional crossing of the River Corrib, thus facilitating the reduction of congestion on city centre roads, and allow the reallocation of road space in the city network to non-motorised modes of transport, thereby facilitating the effective implementation of all the elements contained in the GTS, namely the improvement of public transport, cycling and walking measures

The transport strategy for Galway (i.e. the GTS) has been developed to segregate and direct people to the most appropriate mode, which allows the road component of this strategy to serve the function for which it is designed. The N6 GCRR will serve the strategic traffic currently trying to cross the city via the existing N6 as well as the strategic traffic that is currently trying to rat-run through the city using the existing city street network due to the congestion levels on the national road network. The N6 GCRR will free up road space in the city centre that can be used by other modes of transport. The city at its heart serves a strategic function as the economic engine for the West Region and must be free of congestion to enable it to do so.

The grade separated junctions on the N59 Moycullen Road, N84 Headford Road, N83 Tuam Road and Coolagh Junction provide the necessary connections to distribute traffic in accordance with demand, whilst also being of a standard to comply with TEN-T regulations (ref **Chapter 2, Planning and Policy Context**) which require that all roads that form part of the TEN-T Comprehensive network, as a minimum, be a high quality road. Regulation (EU) No 1315/2013 sets out the requirements for high quality roads that shall form part of the network, both Core and Comprehensive.

The N59 Letteragh Junction is a standard grade separated junction, but is offset from the N59 Moycullen Road. The purpose of this offset from the N59 Moycullen Road is two-fold, firstly to minimise the direct impact on residential property at the N59 Moycullen Road bridge crossing and secondly to provide better connectivity and traffic distribution from the proposed road development to Knocknacarra and the crossing of the N59 Moycullen Road area. The N59 Link Road South connects to the Letteragh Road and Rahoon Road which effectively distributes traffic accessing National University of Ireland, Galway (NUIG) South (south of the Quincentary Bridge), Knocknacarra and University Hospital Galway (UHG), whilst the N59 Link Road North facilitates traffic accessing NUIG North (Sporting Campus), N59 Moycullen Road and Connemara.

The N84 Headford Road Junction is a standard grade separated junction located on the N84 Headford Road to connect with the N84 Headford Road national road traffic. The layout as shown on **Figures 5.1.08** and **5.1.09** is the minimum footprint achievable. However, this junction does directly impact on residential property in this area due to the presence of ribbon development along the N84 Headford Road (ref **Chapter 15, Material Assets Non-Agriculture**).

The N83 Tuam Road Junction is a combined junction to serve the demand arising from the N83Tuam Road and the demand arising from the business parks in the Parkmore and Ballybrit area. As the forecast volume of movements in the N83Tuam Road area could not be accommodated via single junction slips, alternative layouts had to be considered. The solution determined as most suitable and capable of delivering suitable capacity was a merge / diverge arrangement split between the N83Tuam Road and Parkmore Link Road. The key features of this layout are as follows:

- Eastbound diverge from the proposed road development to the existing N83Tuam Road and westbound merge from the existing N83Tuam Road to the proposed road development
- No direct connection from the existing N83Tuam Road to the proposed road development travelling eastbound or no direct connection from the proposed Parkmore Link Road to the proposed road development travelling westbound. However, the forecast volume of such movements was minimal and they were therefore accommodated via the provision of a connection from the proposed Parkmore Link Road to the existing N83Tuam Road, the City North Business Park Link Road

The proposed N83Tuam Road Junction arrangement facilitates the efficient movement of all road users (motor vehicles, buses, trucks, bicycles, and pedestrians). The layout has the benefit of minimising the number of traffic conflicts by segregating the major movements and by providing connections between the proposed and existing road networks as appropriate.

The grade separated junction at the eastern terminus of the N6 at Coolagh provides an efficient partial free-flow transfer of traffic from the existing N6 to the proposed road development. Traffic destined for the eastern part of the city diverges from the existing N6 to an at-grade junction in the vicinity of the existing N6 Coolagh Roundabout. Clear signage at this signalised junction, together with appropriate gantry signage in advance of the split for the proposed road development will enable drivers to make the appropriate choice to arrive at their destination.

5.7 References

DoEHLG and National Construction & Demolition Waste Council (NCDWC). *Best Practice Guidelines for the Preparation of Waste Management Plans for Construction and Demolition Projects*.

BS5489-1, ISEN13201 Code of Practice for the Design of Road Lighting, Part 1: lighting of Roads and Public Amenity Areas

Department for Transport, Tourism and Sport (DTTAS):

- Traffic Signs Manual, 2010
- Design Manual for Urban Roads and Streets (DMURS), 2013

Transport Infrastructure Ireland (TII) Publications:

- DN-GEO-03031– Road Link Design
- DN-GEO-03057– Geometric Design to Improve Surface Drainage
- DN-GEO-03043– Geometric Design of Major/Minor Priority Junctions and Vehicular Access to National Roads
- DN-GEO-03033– Geometric Design of Roundabouts
- DN-GEO-03035– Layout of Grade Separated Junctions
- DN-GEO-03036– Cross-Sections and Headroom.

TII Environmental Guidelines:

- *Guidelines for the Creation, Implementation and Maintenance of an Environmental Operating Plan*

National Transport Authority (NTA), *National Cycle Manual*, 2011

UK DMRB:

- HD 33/06 and 2009 NRA addendum – Surface and Sub-Surface Drainage Systems for Highways
- TD 16/06 and 2009 NRA addendum – Geometric Design of Roundabouts
- TD 22/06 and 2009 NRA addendum – Layout of Grade Separated Junctions
- TD 34/07 - Design of Road Lighting for the Strategic Motorway and Trunk Road Network

6 Traffic Assessment and Route Cross-Section

6.1 Introduction

This chapter presents the potential traffic and transport impacts that may arise from the proposed N6 Galway City Ring Road (N6 GCRR), hereafter referred to as the proposed road development.

The strategic and local traffic and transport impacts associated with the proposed road development are discussed, assessed and evaluated in this chapter which is set out as follows:

- Transportation Assessment Methodology (**Section 6.2**)
- Receiving Environment (**Section 6.3**)
- Future Environment / Proposed Road Development (**Section 6.4**)
- Assessment of proposed road development using Traffic Model (**Section 6.5**)
- Traffic Impact Assessment (**Section 6.6**)
- Mitigation Measures (**Section 6.7**)
- Residual Impacts (**Section 6.8**)
- Summary (**Section 6.9**)
- References (**Section 6.9**)

6.1.1 Guidelines Utilised

This traffic and transport assessment has been prepared with reference to the following documents:

- Project Appraisal Guidelines for National Roads – Transport Infrastructure Ireland (2016)
- EPA: Revised Guidelines on the Information to be contained in Environmental Impact Statements, (2002 and Draft, September 2015)
- EPA: Advice Notes for Preparing Environmental Impact Statements, (2003 and Draft, September 2015)
- Guidelines on the information to be contained in Environmental Impact Assessment Reports – Environmental Protection Agency (Draft 2017) (referred to as EPA guidelines in this chapter)
- Spatial Planning and National Roads – Guidelines for Planning Authorities - DECLG (2012)
- Traffic and Transport Assessment Guidelines – NRA (2007)

- Traffic Management Guidelines – DEHLG, Department of Transport (DOT), Dublin Transportation Office (DTO) (2003)

6.1.2 Key Assessment Terminology

Presented below are some of the key terms that are used throughout this chapter to describe the traffic situation and potential impacts associated with the proposed road development.

- **Heavy Goods Vehicles (HGVs)** are classified as Articulated / Rigid Trucks and Buses with 2 or 3 more axles and vehicles pulling
- **Light Vehicles (LVs)** are classified as Cars, 4 Wheel Drive, Utility and Light Vans
- **Passenger Car Unit (PCU)** is a unit of traffic volume, with 1 LV = 1 PCU and 1 HGV = Approximately 2 PCUs
- **Annual Average Daily Traffic (AADT)** is an estimate of the average daily traffic volume at a location over the course of a year. Calculation of AADT involves dividing the total traffic volume in the year by the number of days in the year. The AADT is a measure of the total traffic over a road and thus is useful for indicating the cumulative impact of traffic on a road pavement. The AADT thus informs road pavement design and maintenance
- **Peak Hour** is the time of the day that travel demand is at its highest, e.g. where there is a lot of commuter traffic, typically 8am to 9am in the morning when commuters are travelling to work and school with a corresponding peak in the evening, usually from 5pm to 6pm. The PM peak is usually less pronounced than the AM Peak period because commuters return home over a wider spread of time in the evening on the return leg of the commute and school related travel typically occurs outside the evening peak
- **Ratio of Flow to Capacity (RFC)** also referred to as **Volume over Capacity (V/C)** is a means to describe the capacity of each approach road to a junction. An RFC below 0.85 (or 0.90 for a signalised junction) implies an approach road is operating satisfactorily within capacity; between 0.85 (or 0.90 for signalised junctions) and 1.0 RFC implies the approach road is operating within capacity but at less than optimal efficiency; above 1.0 RFC the approach road is deemed to be above capacity, therefore, when a road is at capacity a slight increase in traffic volumes can have a disproportionate impact on the length of queuing and delays
- **Transport Infrastructure Ireland (TII) Project Appraisal Guidelines (PAG)** are a set of "how to" appraisal guidelines to ensure consistency of approach across TII projects and compliance with Department of Transport, Tourism and Sport (DTTAS) requirements. The PAG suite of documents include detailed guidance on Transport Modelling, Economic Appraisal and Multi-Criteria Analysis

- **Model Periods** for which transport demand is extracted are as follows:
  - AM peak (07:00 - 10:00)
  - Inter peak 1 (IP1) (10:00 - 13:00)
  - Inter peak 2 (IP2) (13:00 - 16:00)
  - PM peak (16:00 - 19:00)
  - Off peak (19:00 - 07:00)

6.2 Transportation Assessment Methodology

6.2.1 Introduction

The methodology for the traffic and transportation assessment can be summarised as follows:

- Undertake a **baseline review** in relation to the existing traffic situation, including consultation with Galway City and County Councils, Transport Infrastructure Ireland (TII), National Transport Authority (NTA), etc.
- Undertake **traffic modelling** to assess future year scenarios, with the proposed road development ('Do-Something' [1]) and without the proposed road development ('Do-Minimum'[2]) in place
- **Evaluate the traffic modelling results** which forecast the impact of existing and future traffic on the road network
- **Identify any traffic impacts**, develop and test proposed **mitigation measures** to remove and/or reduce any identified negative traffic impacts of major significance
- **Determine any residual impacts** arising from the forecast traffic combined with the proposed mitigation measures

6.2.2 Baseline Review

As a first step, a Baseline Review was produced to determine the existing traffic conditions in Galway City and surrounding areas.

The baseline review, contained within chapters 1 and 2 of the Traffic Modelling Report (included in **Appendix A.6.1**) and summarised in **Section 6.3** and **6.6**, includes a review of the existing road network and the operating transport conditions for vehicular traffic, walking and cycling infrastructure and public transport services. A number of site visits were carried out and traffic surveys were commissioned to determine the existing traffic levels and conditions. The Baseline Review also included a review of demographic information and latest Census data to understand existing levels of travel demand and traffic patterns on the

[1] 'Do-Something' relates to a situation where the proposed road development is approved and proceeds as expected.
2 'Do-Minimum' relates to a situation where the proposed road development does not proceed.

surrounding road infrastructure. Policy documents relating to the area and other relevant background documentation were also reviewed.

As part of the Baseline Review, extensive consultations were held with many key stakeholders including liaising with TII, Galway County Council and Galway City Council to discuss any planned infrastructure and land use changes in the area. Meetings were also held with the NTA to agree the detailed methodologies for traffic modelling since this authority is now responsible for the development and maintenance of the new regional transport model for the West Regional Model (WRM), centred on Galway, which was used as part of this traffic assessment.

6.2.3 Traffic Modelling

6.2.3.1 Traffic Model Development

West Regional Model

The West Regional Model (WRM) is a strategic transport multi-modal model for the counties Galway, Mayo, Roscommon, Sligo, Leitrim and Donegal, with a focus on the city of Galway. It is part of a hierarchical multi-modal transport modelling system for Ireland (known as the 'Regional Modelling System' RMS) that allows the appraisal of a wide range of potential future transport and land use options. The regional models are focussed on the travel-to-work areas of major population centres (e.g. Dublin, Cork, Galway, Limerick, and Waterford).

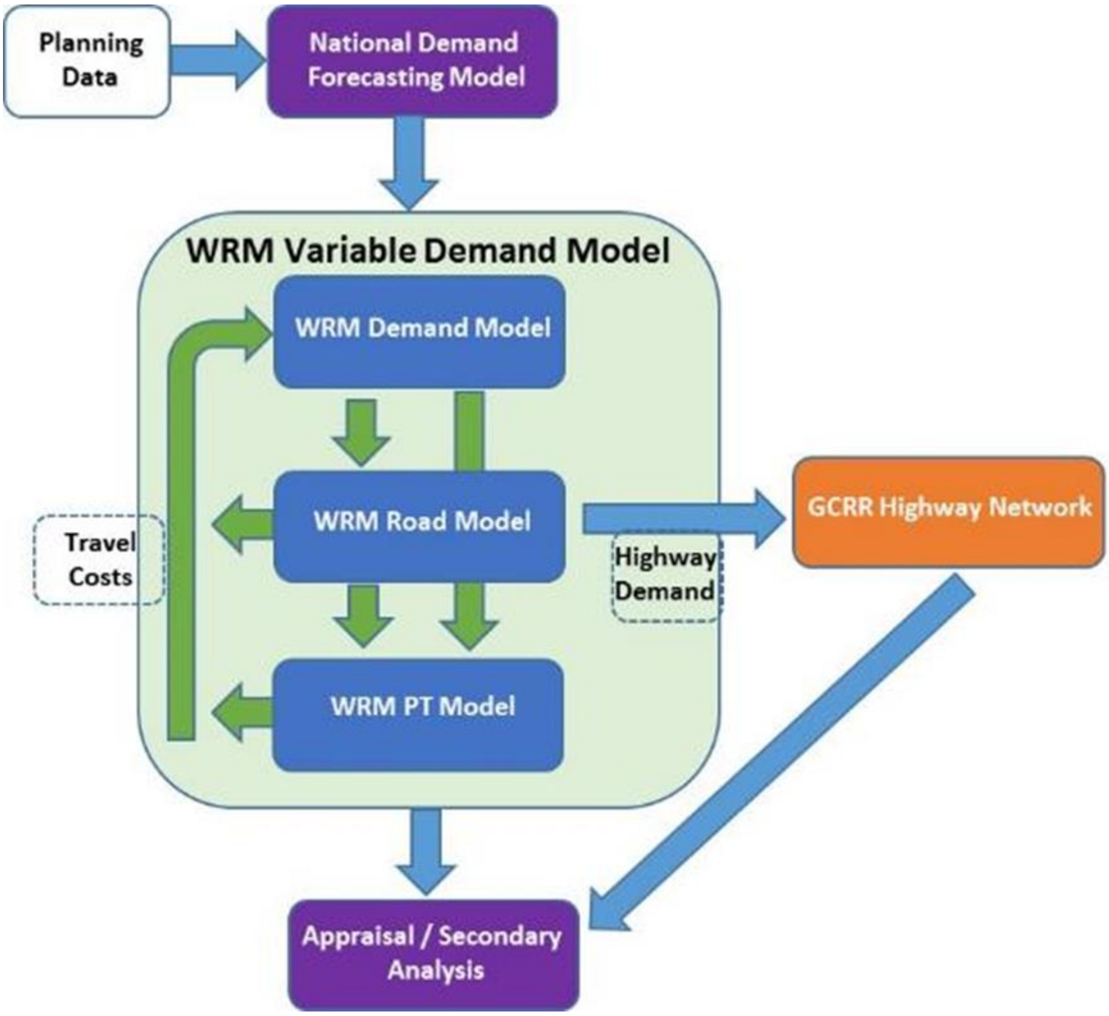
N6 Galway City Ring Road Model

In order to progress the modelling for the design stage (Phase 3 of TII PAG) of the proposed road development it was necessary to improve aspects of the WRM so that the proposed road development model met the required TII PAG model criteria.

To achieve this, the WRM highway models for each time-period (AM, IP1, IP2 and PM) were refined in the area of influence of the proposed road development to provide the base models for the proposed road development assessment (further details of this process are contained within the Traffic Modelling Report, contained in **Appendix A.6.1**).

The completion of the refinement process, resulted in AM, IP1, IP2 and PM highway models of the area of influence of the proposed road development which meet the TII PAG criteria for model development. These highway models are referred to as the **N6 Galway City Ring Road (GCRR) Model**. The demand for these models is derived from the WRM Demand Model and has been used to test the various scenarios required for the proposed road development. The model structure is illustrated in **Plate 6.1** below.

Plate 6.1: N6 GCRR Model Structure



The objective in developing the N6 GCRR Model was to develop a traffic model that accurately reflects existing traffic conditions in the study area at a sufficient level of detail to allow for an accurate traffic assessment. The model software used for the highway assignment element of the model is the SATURN (Simulation Assignment of Traffic to Urban Road Networks) suite of transportation modelling programs. Two peak hour, and two inter-peak hour, models were developed for the purposes of this study to represent the following time periods:

- AM Morning peak period (07:00 – 10:00)
- Average Morning Inter-peak period (10:00 – 13:00)
- Average Afternoon Inter-peak period (13:00 – 16:00)
- PM Evening peak period (16:00 – 19:00)

6.2.3.2 Future Year Model Development

In order to assess the traffic impacts of the proposed road development, two future year models were developed to represent the proposed road development Opening Year (2024) and Design Year (2039).

The future year ‘Do-Minimum’ networks include the base year network plus all schemes (road and public transport) that are already built, are committed to be built or likely to be built by 2024 and 2039. The list of schemes to be included was developed in coordination with Galway City Council, Galway County Council, TII and NTA.

The future year ‘Do-Something’ network includes the ‘Do-Minimum’ schemes plus the proposed road development.

A detailed approach to forecasting travel demand has been developed in order to capture the planned growth in population and employment at a local level in Galway. This approach required input from key stakeholders of the NTA, TII, Galway County Council and Galway City Council.

The following forecast scenarios (and associated demographic forecasts) have been used on this project in order to create future year travel demand:

- **Low Growth Scenario:** NTA Reference Case - These are based on M2F2 Traditional (Scenario 1). The traditional scenario follows the Central Statistics Office (CSO) moderate path of seeing a return towards the 1996 patterns of inter-regional migration (specifically). The population in the West increases at a moderate pace of natural growth in line with the measured outflow of migrants (net) elsewhere
- **Medium Growth Scenario:** TII National Model Medium Growth Scenario
- **High Growth Scenario:** TII National Model High Growth Scenario

In addition to the Core Future Year Scenarios tested (listed above) a further sensitivity test has also been carried out to assess the performance of the proposed road development in conjunction with all the active travel, public transport and road infrastructure proposals included in the **Galway Transport Strategy (GTS)**. As the GTS is a 20-year strategy, this sensitivity test has only been carried out in 2039, Design Year.

Model Application

The models and scenarios described above were used to determine and assess the traffic impacts of the proposed road development.

For further information on model development and application, please refer to the Traffic Modelling Report in **Appendix A.6.1** which contains a full description of the model development and traffic impact analysis process.

6.2.4 Evaluation of traffic modelling results

The traffic model is used to inform various aspects of the EIAR including but not limited to air quality and climate, noise, human beings, population and health and material assets as well as being used to determine traffic impacts associated with the proposed road development (which is the main focus of this chapter).

The AADT flows within the study area were supplied to the design team including environmental experts and used to assess the potential environmental impact of the traffic from the proposed road development. (i.e. air quality and climate, noise, etc.)

The potential traffic impact of the proposed road development is assessed using the N6 GCRR Traffic Model and considers the time periods when traffic congestion is at its most critical in the Galway City area. Key Performance Indicators (KPI) have been identified to assist in the assessment and evaluation of the proposed road development on peak period traffic. Each of the KPIs is quantifiable to allow the scenarios tested to be easily compared against one another to determine traffic related impacts.

The following KPIs have been used to determine traffic impacts:

- Journey Times on Key Routes
- Ratio of Flow (of Traffic) to Capacity ratio at Key Junctions (i.e. a measure of congestion levels)
- Network Statistics

Journey times on key routes have been considered to determine the traffic impact of the proposed road development on the strategic road network. Ratio of Flow to capacity (or degree of saturation ratios) at key junctions have been considered to take account of local traffic impacts. Finally, model network statistics give an overall, general, assessment of the performance of the entire model network (which covers Galway City and its environs) for a given scenario.

All three KPIs are used for the traffic impact assessment as one KPI may reveal a traffic impact that is not picked up by another KPI. For this reason all three KPIs are used to inform the full range of potential traffic impacts.

The impacts of the proposed road development, both at the strategic and at local levels, are rated as positive, negligible, minor, moderate or major, as appropriate and these categories are described as follows:

- **Positive:** effects improve conditions
- **Negligible:** effects that are of such low importance that they are not material to decision-making
- **Minor Significance:** effects that are of low importance in the decision-making process
- **Moderate Significance:** effects of the proposed road development that may be judged to be important at a local scale (i.e. in the planning context) only
- **Major Significance:** effects of the proposed road development which are of greater than local scale importance (i.e. strategic significance)

The likelihood (low, medium or high) and duration (short, medium or long term) of the predicted impacts is also assessed and noted. As per EPA guidelines, short-term equates to 1-7 years, medium term is between 7 and 15 years and long term is between 15 and 60 years. This method of rating impacts allows the traffic modelling scenarios to be compared in a clear, concise and measurable way.

Mitigation measures of traffic impacts of major significance identified are developed and are further evaluated if required.

The remaining residual impacts are also considered.

6.3 Receiving Environment

6.3.1 Existing Road Network

The existing road network is shown on **Plate 6.2**. The existing N6 is a four lane carriageway between Coolagh, Briarhill and the N59 Moycullen Road, with varying median width, and a number of at-grade roundabouts and signalised junctions. There are various forms of at-grade junctions including roundabouts, signals and priority junctions on the R338 from its junction with the N59 Moycullen Road to the R336 Coast Road.

The M6 motorway becomes the N6 National Road to the east of Galway City and is the primary access to Galway from the east. The existing N6 connects to the local road network at Coolagh Roundabout, an at-grade junction which experiences congestion during the morning peak hour. The existing N6 then turns north to Briarhill Junction, an at-grade signalised junction, which connects to R339 Monivea Road and onto Parkmore Road. This junction experiences capacity problems (refer to **Section 6.3.5** below) during both the morning and evening peak hour due to the volume of traffic trying to access/egress the Industrial Estates at Parkmore, Ballybrit and Briarhill.

The existing N6 continues as a dual carriageway to the at-grade signalised junction at the Ballybane Junction and onto the N83 Tuam Road[3], again a signalised junction. This particular junction experiences delays at peak hours due to the traffic volumes on the N83 Tuam Road being equivalent to the volumes on the existing N6. The dual carriageway continues to the Kirwan Roundabout, i.e. the junction of the existing N6 and the N84 Headford Road. This five arm at-grade roundabout experiences delays at peak hour due to the strongest demand controlling the flows onto the roundabout (refer to **Section 6.3.5** below). Again, the traffic volumes on the N84 Headford Road are of the same order as the traffic volumes on the existing N6 at this point.

The N6 Headford Road between the Kirwan Roundabout and the Bodkin Junction is one of the busiest roads in the city carrying approximately 32,000 vehicles per day. This short section also has two additional traffic signals to facilitate access to retail and residential areas. The existing N6 over the Quincentenary Bridge, to the west of the Bodkin Junction, carries approximately 34,600 vehicles per day (as per 2012 traffic count data). This volume decreases on the west of the river as traffic

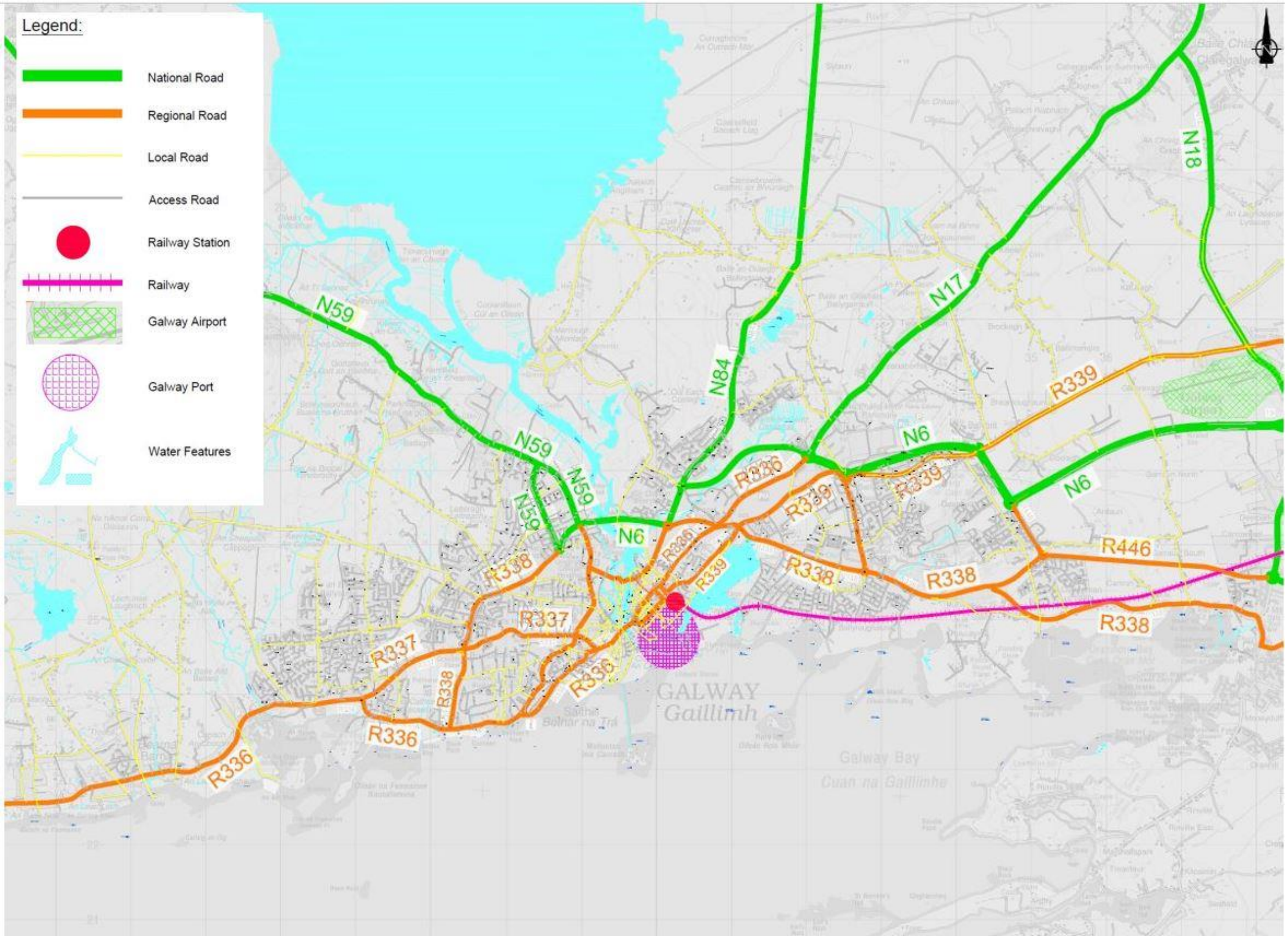
[3] Formally known as the N17 Tuam Road

accesses the university and the hospital at the existing N6/Newcastle Road and existing N6/N59 Browne Roundabout Junctions, However, the R338 Seamus Quirke Road to the west of Browne Roundabout, which is a single carriageway plus bus lanes, carries approximately 24,000 vehicles per day along a busy street with frontage, retail accesses, cyclists and high pedestrian usage.

The R338 then connects to the R336 Coast Road by continuing south along Threadneedle Road. There are two major secondary schools, and three primary schools in the vicinity of Threadneedle Road, all of which contribute to delay.

Therefore, the existing N6 weaves a route through many at-grade junctions from east to west around Galway City. The proximity of the junctions and the frequency of these junctions does not facilitate movement of vehicles in a timely manner or in a reliable manner. It also hinders and discourages modal shift as the public transport vehicles are also experiencing similar delays and such congested streets are perceived as dangerous for cyclists and pedestrians.

Plate 6.2: Existing Road Network



6.3.2 Existing Travel Patterns

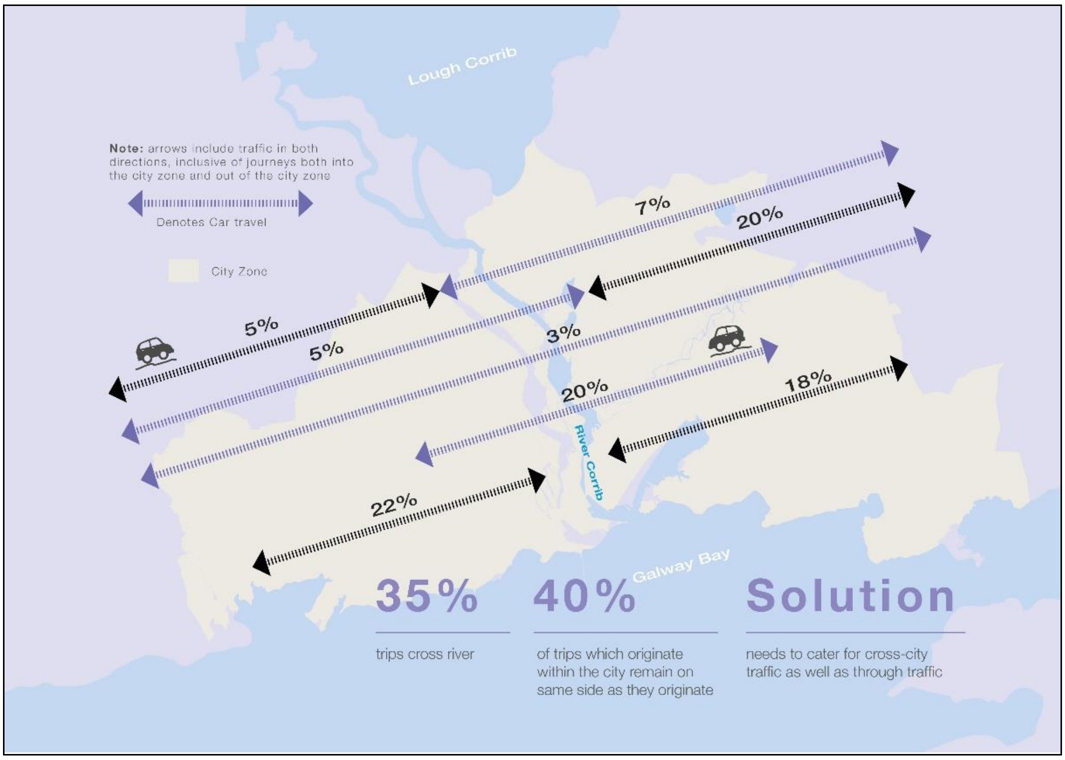
An analysis of desire lines for travel in Galway City and its environs has been undertaken using the West Regional Model to gain an understanding of travel patterns in the proposed road development study area. This has been developed using the extensive information on trip origins and destinations incorporated into the base year transport model. The model is divided up into approximately 300 zones, which have been aggregated to 16 sectors for the purposes of establishing the desire lines or demand between the sectors. The desire line analysis can be further aggregated into a broad representation of strategic travel patterns in Galway City and its environs focusing on trips that cross the River Corrib and that either travel into Galway City or travel through the city.

Plate 6.3 below is a schematic diagram to illustrate the travel patterns for private car trips to, from or through Galway City in the 2012 Base Year morning peak hour (extracted from the traffic model). Red arrows show movements that cross the River Corrib and green arrows show movements that do not cross the River Corrib.

As discussed in **Chapter 3, Need for the Proposed Road Development**, in total 35% of total car trips into and around Galway City cross the River Corrib. Of this total number of cross-river trips, approximately 3% are bypass traffic. Some 40% of all trips remain on the same side of the city as where they started i.e. that is to say the trip commences in the city and terminates in the city but does not cross the river.

One of the strongest movements is from the west side of Galway City to the east side of Galway City and vice versa which represents 20% of all trips. This analysis implies that any proposed development must cater for movements from one side of the city to the other in addition to through traffic, rather than a conventional bypass of the city which would mainly cater for through traffic. This analysis also demonstrates the importance of an integrated solution which supports modal shift for shorter commutes.

Plate 6.3: Travel Patterns 2012 Base Year Morning Peak Hour



6.3.3 Existing AADT on key links

The following Average Annual Daily Traffic (AADT) flows were estimated based on traffic counts undertaken by Galway City Council November 2012 and 2013 along the existing N6:

- N6 between Coolagh Roundabout and Monivea Road – 21,400 AADT
- N6 at Galway Racecourse – 19,900 AADT
- N6 between Tuam Road and Kirwan Roundabout – 22,400 AADT
- N6 River Corrib Crossing – 34,600 AADT

These volumes are significant volumes given the fact that these roads are also part of the street network serving Galway City.

Existing Peak Hour Flows and Level of Service

Average weekday peak hour traffic flows on the existing N6, within the Galway urban area have been derived from the November 2012 traffic surveys and are presented in **Table 6.1**.

Table 6.1: N6 Peak Hour Traffic Volumes (November 2012)

Road	Location	C'way	Direction	AM Peak (08:00 - 09:00)	PM Peak (17:00 - 18:00)
N6	Quincentenary Bridge	Single	Eastbound	1,614	1,357
			Westbound	1,466	1,520
N6	North of Bodkin Roundabout	Single	Northbound	1,315	1,132
			Southbound	1,286	1,052
N6	Terryland	Single	Eastbound	925	885
			Westbound	1,000	1,000
N6	Galway Racecourse	Dual	Eastbound	881	1,178
			Westbound	905	1,357
N6	Coolagh	Dual	Northbound	1,274	731
			Southbound	490	1,201
N6	Ardaun	Dual	Eastbound	601	1,183
			Westbound	930	603

TA 79/99 of the UK DMRB is used to determine the capacity of urban roads. This standard is not formally implemented in Ireland but is considered as background reading which indicates good practice. Within this standard, classifications such as Urban Motorways or Urban All Purpose roads are used, with further sub-classification of Urban All Purpose Roads as UAP1 to UAP4. The existing N6 in Galway can be defined as a UAP2 which refers to a "good standard single/dual carriageway road with frontage access and two side roads per km". From TA 79/99, a 2 lane UAP2 road has a capacity of approximately 1,470 vehicles per hour for a 7.3m wide 2 lane single carriageway. This capacity increases to 3,200 vehicles per hour for a 7.3m wide 2 lane dual carriageway. This does not account for capacity issues at the junctions.

When the existing volumes are compared against the theoretical capacity, the 4 lane single carriageway section of the existing N6 between the Quincentenary Bridge and Terryland are frequently at or above the capacity threshold defined in TA 79/99, which results in congestion on the route and a reduced level of service. Lower traffic volumes are carried on the dualled eastern section of the N6 Bóthar na dTreabh, however congestion is still experienced along this section, due to capacity restrictions at junctions, of which there are many as this also forms part of the street network serving Galway City.

6.3.4 Journey Time Reliability Assessment

Peak hour congestion on the road network in Galway, predominantly caused by junction capacity issues, results in increased journey times in peak periods in Galway. This leads to a reduction in journey time reliability in the city during these periods.

An analysis of observed journey times on three key routes around Galway and its environs was carried out to show the variance in journey times between the peak and off-peak periods in the base year. The three key routes are shown on **Plate 6.4**. The difference between the peak and off-peak journey times is a measure of the level of congestion during the peak, and increasing congestion results in worsening journey time reliability.

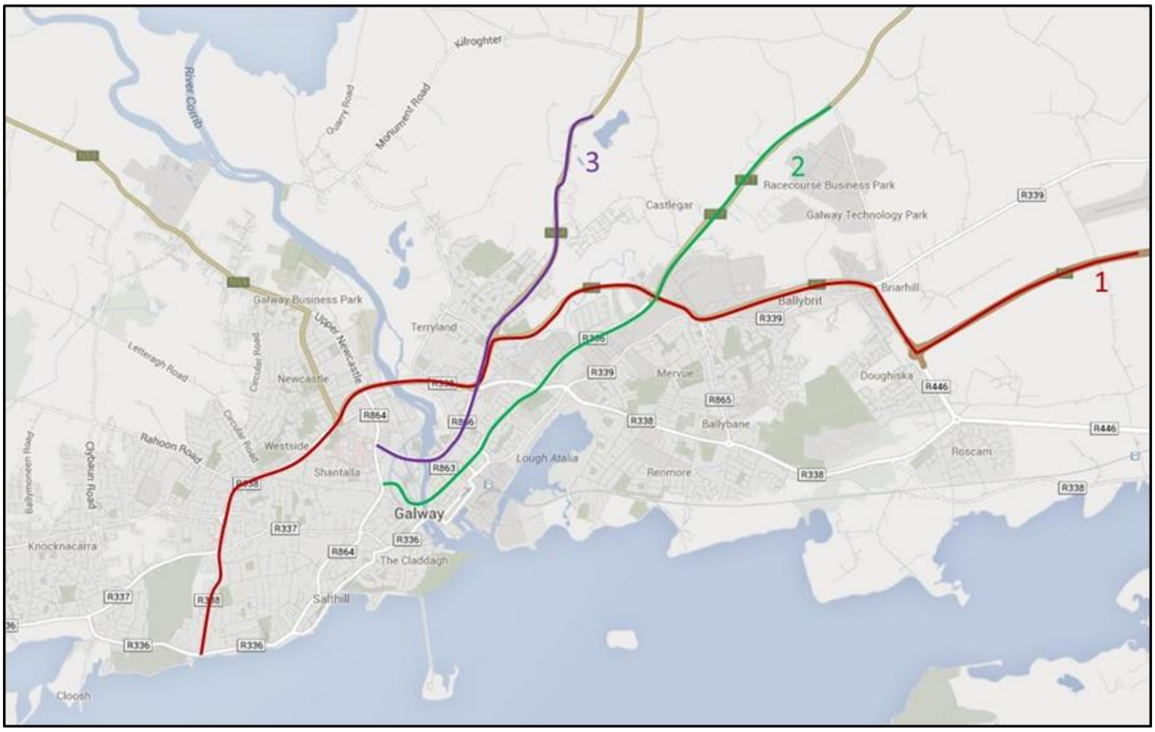
Observed travel times in 2012 Base Year on each of the routes in the inbound direction in the morning peak period versus the off-peak period are tabulated in **Table 6.2** below.

This assessment of journey time shows that the travel times on these three key routes in the morning peak hour are on average more than double the off-peak travel times.

Table 6.2: Journey Time Reliability

		2012 Observed Journey Times (minutes)			
		Off-peak average hour	**Morning peak hour**	**Difference**	**% Difference**
Inbound	Route 1 IN	14	28	14	100%
	Route 2 IN	14	25	11	79%
	Route 3 IN	8	19	11	138%
	Average	12	24	12	105%

Plate 6.4: Journey Time Reliability Routes



6.3.5 Junction Capacity Assessment

In the urban area, junction capacity is the key contributor to road congestion, over and above link capacity. Therefore, an assessment of the ratio of flow to capacity was undertaken at signalised junctions and roundabouts, plus other key junctions in the study area as shown on **Plate 6.5**. Data was extracted from the 2012 AM Peak Base Year traffic model to show the maximum volume-to-capacity ratio for the turns at each junction. The volume to capacity ratios are then related to level of delay and congestion at the junctions.

Plate 6.5: Volume/Capacity Ratios at Junctions (2012)

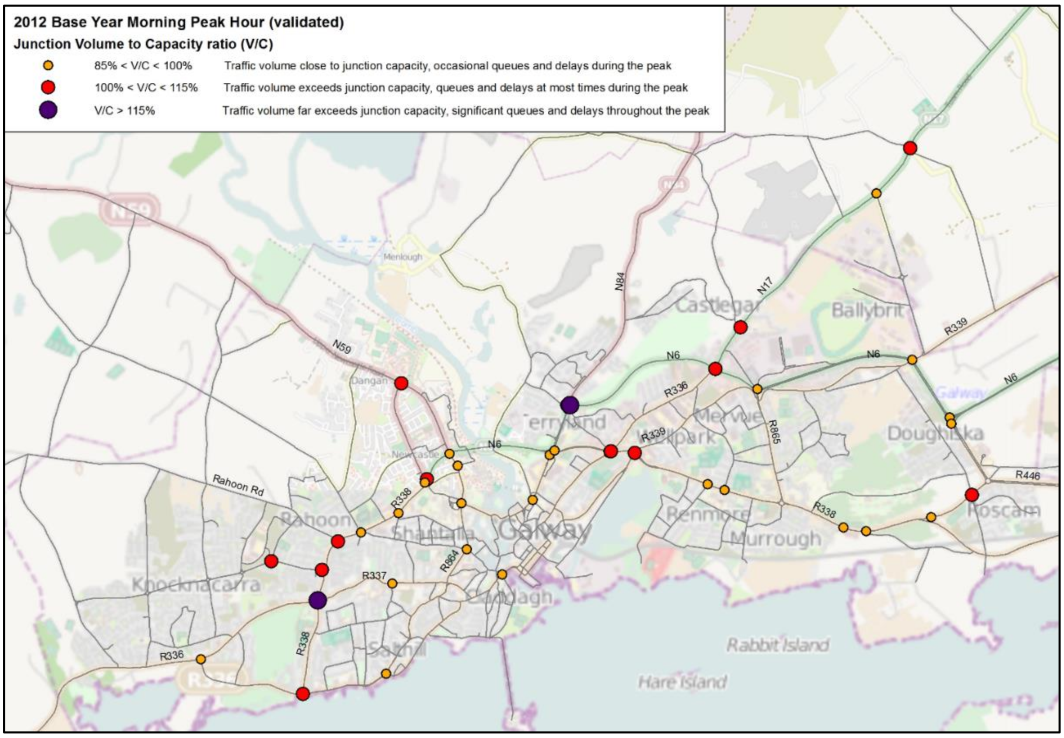


Table 6.3 summarises the number of junctions with a max turn RFC within standard ranges of 0.85-1.00, 1.00-1.15 and >1.15. Junctions with a RFC greater than 1 are over capacity. Ideally junctions should operate at a RFC ratio of < 0.85 (or 0.90 for signalised junctions), which would allow 15% spare capacity in the junction to cope with an unexpected event or natural growth.

This analysis demonstrates that the existing network is restricted by junction capacity. The junctions on the critical corridors accessing the city, namely the junctions of the N84 Headford Road, N83 Tuam Road and N59 Moycullen Road junctions with the existing N6, currently have no spare capacity at peak hour as shown on **Plate 6.5** above. These junctions are operating at greater than 100% of their capacity, which in turn leads to delays at these junctions. As these junctions are the main arteries into the city and the main junctions on the circumferential route around the city, this is a significant issue for the Gateway of Galway.

In addition, approximately 40% of all junctions on the key access routes across the study area are operating above 85% capacity during peak periods. This demonstrates that the network is finely balanced with minimal spare capacity to allow for any unforeseen event or natural growth.

Table 6.3: Junction Volume/Capacity Ratio (2012)

Sector	Sector Name	0.85 – 1.00	1.00 – 1.15	> 1.15
1	City Centre	2	0	0
2	City West	2	0	0
3	City East	3	1	0
4	R338 West	5	1	0
5	R338 East	1	2	0
6	N6	8	4	1
7	Western Distributor	0	0	0
8	R336	4	0	0
9	N59/Newcastle Road	0	1	0
10	N84	0	0	1
11	N83	2	1	0
12	R339	0	0	0
13	N6 from M6	0	0	0
Total	-	27	10	2

6.3.6 Alternative Modes

6.3.6.1 Existing Bus Network Conditions

Galway City is served by Bus Éireann and a small number of private operators. The city bus infrastructure is very much discontinuous, with priority measures only provided along sections of key corridors and not continuous over any significant portion of the network. As such the city bus network is subject to delay, impacting the attractiveness of the bus as a mode of choice.

In addition to the city bus network, a number of regional bus service providers operate to and from the city. Regional, intercity and private tourist coach services are subject to delays due to infrastructural deficiencies approaching and within the city centre, where the principal destinations are located at Ceannt Station, Fairgreen Coach Station, Eyre Square/Merchants Road and Galway Cathedral. These delays, along with multiple centralised destinations in the city centre and a lack of cohesion with the city bus routes and ticketing systems, discourage use of regional bus services for commuters from surrounding towns and villages which are served directly by regional buses.

National coach services benefit from high-quality road connectivity from the east and south, increasingly of motorway standard with the relatively recent construction of the M6 and the current development of the M17/M18, which will also improve connectivity to the north-east. Similar to the regional services, there are numerous operators providing intercity services to and from the city, with a resultant high number of arrivals and departures daily from Ceannt Station and Fairgreen Station.

These services are also subject to delays due to infrastructural deficiencies approaching and within the city centre, which discourages use of public transport between cities, and may impact on tourism in Galway City if accessibility of the city is not improved.

6.3.6.2 Existing Rail Network

Galway City is served by the existing single-track heavy commuter rail line from the east, terminating in the city centre at Ceannt Station. The rail line connects to Oranmore/Garraun and Athenry to the east. From Athenry there is a connection to the Western Rail Corridor service from Limerick and Ennis, and the main line continues east to Dublin.

There are 10 daily services scheduled from Ceannt Station to Heuston, and 9 scheduled return services from Heuston to Ceannt, with journey time being as short as 130 minutes.

There are eight scheduled daily services between Ceannt Station and Colbert Station in Limerick, and eight scheduled return services, with journey time being as short as 90 minutes.

6.3.6.3 Existing Pedestrian Network

The majority of the study area is provided with pedestrian facilities of varying quality. Within the city centre, there are pedestrian-only streets which are a key asset to the local economy, in particular the tourism/shopping thoroughfare of William Street, Shop Street and Quay Street. Other pedestrian facilities of note include the city canal network and the promenade at Salthill.

There have also been major junction improvement schemes in recent years which have considerably improved the pedestrian offering across the city and suburbs.

However, numerous locations throughout the study area remain where the quality of the pedestrian facilities is poor. At certain locations in the city centre, private and public vehicular traffic impacts on the safety and comfort of pedestrians. There are streets throughout the city with substandard or missing footpaths, limited or no crossing facilities, and permeability issues resulting from the manner in which residential areas have been developed. Some suburban residential areas are accessible by direct routes, but these are substandard and not suitable for use by mobility impaired pedestrians, while others have no footpaths provided for pedestrian access to main thoroughfares. The absence of permeability within housing areas often leads to excessively circuitous trips for pedestrians to walk a relatively short distance. All of these factors discourage walking as a mode for short trips.

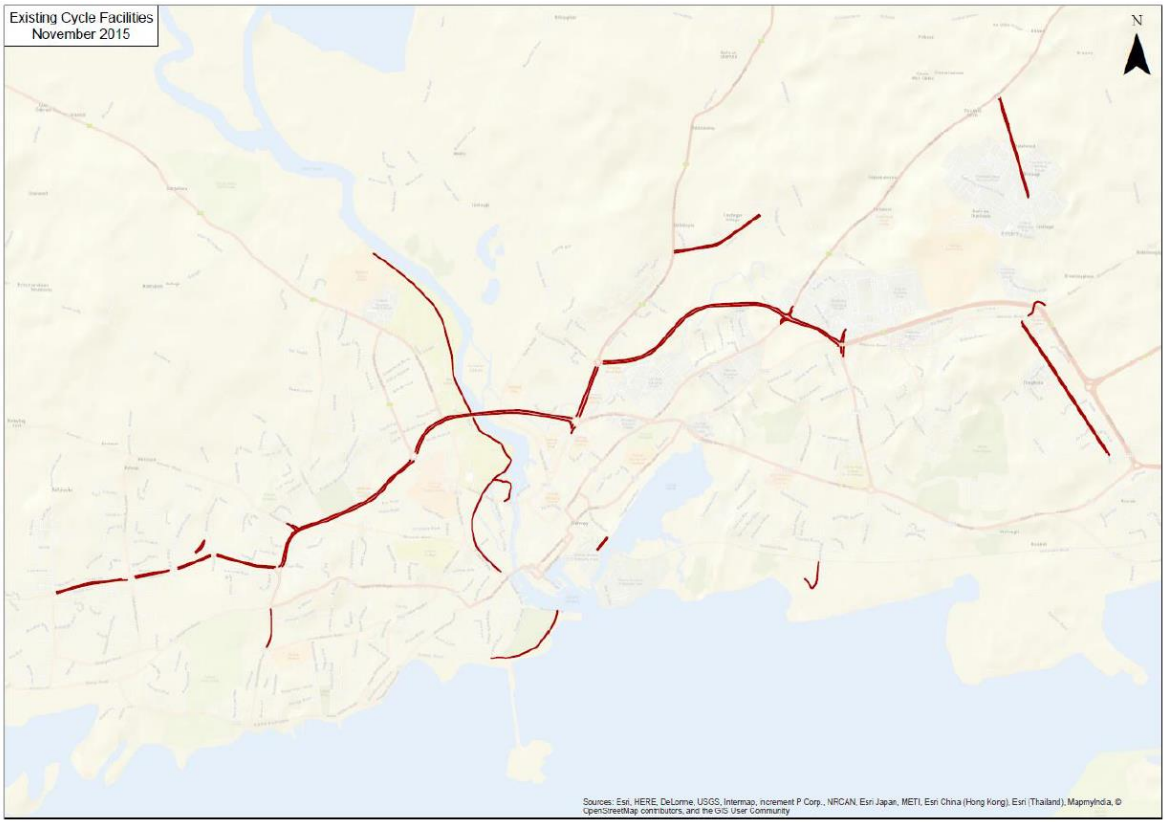
6.3.6.4 Existing Cycle Network

Although the city's generally flat topography is conducive to cycling as a suitable mode of travel, the current mode share of 5% is relatively low. Similar to the bus network, the existing network of cycle infrastructure is limited and discontinuous.

Plate 6.6 below shows the extent of the current cycle network.

The volume of vehicular traffic on the narrow city centre streets of Galway City also contributes to an environment that is neither appealing nor perceived as particularly safe for cycling. While there have been numerous improvements in recent years to the cycle network, not least the roll-out of the Bike Share Scheme, and several schemes in development aimed at enhancing the network, the cycling environment remains limited. This is particularly true in areas outside the city, where many towns and villages are within cycling distance of the city and each other, such as Bearna, Oranmore, Moycullen and Claregalway.

Plate 6.6: Extent of Existing Cycle Network Infrastructure



6.4 Future Environment / Proposed Road Development

6.4.1 Characteristics of the Proposed Road Development

The proposed road development, as described in detail in **Chapter 5, Description of the Proposed Road Development**, comprises the construction of a single carriageway from the western side of Bearna as far as the Ballymoneen Road and a dual carriageway from Ballymoneen Road to the eastern tie in with the existing N6 at Coolagh, Briarhill, and associated link roads, side roads, junctions and structures. The proposed road development also incorporates some facilities for non-motorised users which have been identified as part of the Galway Transport Strategy.

The design of the proposed road development is shown on **Figures 5.1** to **5.14** of this EIAR.

6.4.1.1 Proposed Road Type and Cross-Section

From the R336 Coast Road to Ballymoneen the mainline carriageway of the proposed road development is a Type 1 Single Carriageway in accordance with TII DMRB DN-GEO-03036 (Cross Sections and Headroom). The design speed of the mainline over this area is 85km/h, and the cross section is as outlined within **Chapter 5, Description of the Proposed Road Development**.

From Ballymoneen Road to the eastern tie in with the existing N6 at Coolagh, Briarhill, the mainline of the proposed road development is a Standard Dual Carriageway Urban Motorway (D2UM) in accordance with TII DMRB DN-GEO-03036. The design speed of the mainline over this area is 100km/h and cross section is as outlined within **Chapter 5, Description of the Proposed Road Development**.

The section of the proposed road development between the N83 Tuam Road and N84 Headford Road Junctions is a 3 lane dual carriageway. The total length of this section is approximately 1,850m.

6.4.2 Selection of Road Type

The appropriate cross section/road type of the proposed road development was determined based on a number of influencing factors which are discussed below.

6.4.2.1 TEN-T Network

As discussed in **Chapter 2, Planning and Policy Context** and **Chapter 3, Need for the Proposed Road Development**, the proposed road development forms part of the Trans European Transport Network (TEN-T) Comprehensive Network which has implications on the choice of cross-section as set out below.

The TEN-T requires that all roads that form part of the network, as a minimum, be a high quality road. Regulation (EU) No 1315/2013 sets out the requirements for high quality roads that shall form part of the network, both Core and Comprehensive, and states under Article 17(3), the following:

"High-quality roads shall be specially designed and built for motor traffic, and shall be either motorways, express roads or conventional strategic roads."

6.4.3 Incremental Assessment

An incremental assessment was undertaken to determine the carriageway cross section, design speed and the extent of the proposed road development. The objective of this assessment was to examine the alternative cross sections available, alternative design speeds and alternative scheme extents in order to determine the most suitable combination.

The incremental assessment identified the following as the most suitable combination for the proposed road development:

- Single carriageway with a design speed of 85km/h from the R336 to Ballymoneen Road
- Type 1 dual carriageway with a design speed of 100km/h from Ballymoneen Road to the N59 Junction
- Urban motorway with a design speed of 100km/h from N59 Junction to the existing N6. It has been determined that the section of the proposed road development between the N84 Headford Road and N83 Tuam Road is to be 3 lanes in each direction, the remaining sections are 2 lanes in each direction

This combination was selected as the most suitable for the following reasons:

- It provides a high level of provision for the transportation infrastructure in Galway City and environs
- The combination complies with the TEN-T regulations noted as it allows access to be restricted to junctions only
- The combination can accommodate the forecast traffic volumes for the Design Year

6.4.3.1 Junction Strategy

The objectives considered in determining the junction strategy include the following:

- Restriction of access to junctions as the proposed road development is of strategic importance and part of the TEN-T Comprehensive Network
- Connectivity to National and Regional road network
- Serve existing travel demand by all modes
- Junctions located so as to relieve traffic congestion
- Sufficient junctions to provide a minimum level of accessibility to the region to support further economic, social and territorial development
- Junction form to deliver capacity as experience has shown that the network breaks down due to junction failure due to capacity problems

- Promote a mobility that is efficient and safe

The junction strategy of the proposed road development has been designed to meet these objectives. The strategy meets the objectives for the following reasons:

- Provides a high quality road with limited access in accordance with TEN-T designation
- Provides connectivity to the national roads via junctions to maximise the transfer of cross-city movements to the new road infrastructure, thus releasing and freeing the existing city centre zone from congestion caused by traffic trying to access a city centre bridge to cross the River Corrib
- Improves connectivity to the Western Region i.e. the county areas and hinterland beyond the city zone
- Caters for the strong demand between zones on either side of the city
- Facilitates crossing the River Corrib without negotiating the city centre
- Provides this additional river crossing with connectivity back to the city either side of the River Corrib Bridge and provides essential city street links to better distribute traffic
- Attracts traffic from the city centre zone thus facilitating reallocation of road space to public transport leading to improve journey time reliability for public transport, supporting a mobility that is efficient and safer environment for active modes
- Facilitates improved city centre environment for all due to reduced congestion, thus encouraging walking and cycling as safe transport modes

6.4.4 Future Transportation Network

6.4.4.1 Future Highway Network

The future year highway networks include the 2012 base network plus all of the schemes that are already built, are committed, or are likely to be built by 2024 and 2039 (Opening and Design Years). The list of schemes to be included was developed in coordination with Galway City Council, Galway County Council, the NTA and TII.

The complete list of road schemes included in the future year networks is available in the Traffic Modelling Report (**Appendix A.6.1**). Some of the key network upgrades included are:

- Kirwan Roundabout Upgrade
- Browne Roundabout Upgrade
- M17/M18 Gort to Tuam Motorway
- Various other junction improvements and reconfigurations throughout Galway City

6.4.4.2 Future Alternative Modes

As mentioned previously, Galway County Council, Galway City Council, and the National Transport Authority (NTA) worked collaboratively in developing an integrated transport strategy to resolve the existing transportation issues in Galway City and its environs. The transportation solution developed includes a smart mobility component, public transport and active mode component and a road component and is known as the Galway Transport Strategy. The Galway Transport Strategy (GTS) aims to address the current and future transport requirements of the city and its connectivity to surrounding towns and villages, including Bearna, Oranmore, Moycullen and Claregalway.

The GTS, which has been adopted by both Galway City and County Councils, sets out a series of actions and measures, covering infrastructural, operational and policy elements to be implemented in Galway over the next 20 years and sets out a framework to deliver the projects in a phased manner. It identifies that Galway has a transport problem due to its reliance on the private car, which has been influenced by the existing public transport network, limited cycling facilities, a large rural hinterland and being the key gateway in and out of Connemara. Combined with this, it has a road and street network which is ill-suited to the high traffic flows currently prevalent and contributing to increased congestion and delay, affecting quality of life and impacting on the functionality of the city. To address this, a fundamental shift is needed towards sustainable travel, reducing the dependency on the private car and taking action to make Galway more accessible and connected, enhancing quality of life within the city for all. Galway City Council are seeking to make Galway an exemplar of Smarter Travel in Ireland. The proposed road development forms part of the GTS as the main road component of the overall transport solution for Galway City and its environs.

The GTS outlines a host of proposed measures for active travel, public transport and general traffic in Galway, to be implemented over a 20-year period. Some of the key proposals included in the Strategy are listed below:

- A Public Transport Corridor through the City Centre with Public Transport Only allowed on the Salmon Weir Bridge, Eglington Street and College Road
- Localised City Centre Traffic Management Proposals
- An outer orbital route (proposed road development) to enhance resilience of the GTS
- Rationalise Bus Route network and increase service frequencies
- Provision for Park and Ride

A full list of the proposals is contained within the GTS Report, “Galway Transport Strategy, An Integrated Transport Management Programme for Galway City and Environs, September 2016”.

6.5 Assessment of Proposed Road Development using Traffic Model

6.5.1 Travel Demand Forecasts

As mentioned previously, the future year traffic forecasts for the proposed road development were developed in accordance with TII project appraisal guidelines and use demographic forecasts from the National Traffic Model (NTM), the National Transport Authority planning unit and Galway City and County Councils.

The following forecast scenarios were agreed, with TII and Galway City and County Council, for use on this project:

- Low: NTA Reference Case - These are based on M2F2 Traditional (Scenario 1). The traditional scenario follows the Central Statistics Office (CSO) moderate path of seeing a return towards the 1996 patterns of inter-regional migration (specifically). The population in the West increases at a moderate pace of natural growth in line with the measured outflow of migrants (net) elsewhere
- Medium: TII National Model Medium Growth Scenario
- High: TII National Model High Growth Scenario

For the medium and high growth scenarios, TII population and employment forecasts were taken at an Electoral Division (ED) level (smallest available) and distributed among the Census Small Areas and model zones based on a combination of the existing distribution and NTAs forecast distributions.

In the case of the Low Growth Scenario, the NTA applied a top-down approach to distribute the population forecasts across the census small areas (CSAs) within the WRM.

An assumption was made that the overall growth in employment would be in line with the population growth. This methodology is consistent with the approach adopted in the demographic forecasts for the TII National Transport Model.

6.5.2 Assessment Years

In addition to the Base Year (2012), two assessment years were modelled, these were 2024 and 2039. 2024 was chosen as the proposed Opening Year of the proposed road development. As per TII Traffic and Transport Guidelines, the proposed road development must also be assessed for a future year of 15 years after the first year of operation, and therefore 2039 is chosen on this basis.

For each of the modelled years, the road network and travel demand included in the traffic model reflects the projected infrastructure and population growth scheduled to be in place at that particular stage.

Two business as usual scenarios (i.e. ‘no road development’) entitled Do Minimum 2024 and Do Minimum 2039 are used to represent the base situation against which other scenarios are compared. This comparison demonstrates the impact of the proposed road development, when compared to a scenario without the proposed development in place. The two ‘development’ scenarios are entitled Do Something 2024 and Do Something 2039.

6.5.3 Scenarios Tested

6.5.3.1 Modelled Scenarios

Core Tests

As previously described, the future year ‘Do-Minimum’ network includes the 2012 base network plus all of the schemes (road and public transport) that are already built, or are committed, or likely to be built by 2024 and 2039.

The future year ‘Do-Something’ networks include the Do-Minimum schemes plus the proposed road development. In addition to the validated 2012 Base Year network, the following future year networks have been developed and tested using the Medium Growth Travel Demand Forecasts:

- 2024 Opening Year Do-Minimum
- 2024 Opening Year Do-Something
- 2039 Design Year Do-Minimum
- 2039 Design Year Do-Something

Galway Transport Strategy

In addition to the Core Scenarios tested (listed above) a further test has also been carried out to assess the performance of the proposed road development in conjunction with all of the active travel, public transport and road infrastructure proposals included in the Galway Transport Strategy. As the GTS is a 20-year strategy, this sensitivity test has only been carried out in 2039, Design Year.

6.5.3.2 Low and High Growth Sensitivity Tests

Each of the scenarios listed above have been assessed further utilising the Low and High growth travel demand forecasts which have been described in **Section 6.5.1**.

6.6 Traffic Impact Assessment

6.6.1 Identification and Scale of impacts

The impact assessment process introduced in **Section 6.2.3** is used to identify and measure potential traffic impacts generated by the proposed road development. 'Do Minimum' scenarios, i.e. without the proposed road development, are compared to 'Do Something' scenarios, i.e. with the proposed road development in place. Construction impacts associated with constructing the proposed road development etc. will also be assessed.

The 'Do Minimum' and 'Do Something' scenarios are compared for the same year, i.e. 2024 or 2039, and therefore, other than the proposed road development, the same infrastructure is assumed for the scenarios which are being compared.

To recap, and as discussed previously in **Section 6.2.3**, three Key Performance Indicators (KPI) have been identified which will assist in the assessment and evaluation process which will determine the traffic impact of the proposed road development on these roads during peak hours. The three KPIs are:

- **Journey times** on key routes – to understand strategic impacts
- **Network Statistics** – Network wide indicators of congestion and delay
- **Ratio of Flow to Capacity (RFC)** at Key Junctions – to understand local impacts, congestion and queues

Using these KPIs, the traffic impacts of the proposed road development is assessed at both a strategic and local level.

6.6.1.1 Journey Times

To develop an understanding of the potential impact of the proposed road development on key routes serving Galway City and its environs, the projected change in vehicular journey times were assessed. Journey times represent a good basis for strategic traffic impact assessment as they provide a mechanism to quantify the traffic impact along a full route. This KPI is based on a comparison between the 'Do-Minimum' journey times (i.e. without the proposed road development) and the 'Do-Something' journey times (i.e. with the proposed road development). Both the percentage change and absolute change in journey times (seconds) is considered in order to determine the impact, as shown in **Table 6.4** below.

The journey time routes used for the assessment of impact are shown in **Plate 6.7**. This KPI, therefore, assesses the strategic traffic impact of the proposed road development.

The impact scale used for journey times has been developed using the 2011 Census travel statistics for Galway and locally based traffic survey information. These CSO Census 2011 statistics state that the majority of journeys to work (62%) in Galway County took under 30 minutes and only 15% of workers faced a commuting time in excess of 45 minutes.

Table 6.4: Representation of Negative Impact on Vehicle Journey Times

		Absolute Difference (seconds)			
		<60	60-120	120-240	>240
% Change	<5%	Negligible	Negligible	Minor	Moderate
	5-10%	Negligible	Minor	Moderate	Moderate
	10-20%	Minor	Minor	Moderate	Major
	>20%	Minor	Moderate	Major	Major

A Green Box would indicate a positive impact between the Do-Minimum and Do-Something Scenario

Plate 6.7: Journey Time Routes

Table 6.4 is interpreted as follows - the impact is considered “Major” if the change in journey time, when comparing the ‘Do-Minimum’ and ‘Do-Something’ scenarios, is greater than 240 seconds and the percentage change is greater than 10% or the time increase is between 120 – 240 seconds and percentage change is greater than 20%.

In situations where the journey times decrease, i.e. the change in journeys time when comparing the ‘Do-Minimum’ to the ‘Do-Something’ scenarios is negative, this impact is described as ‘Positive’.

Journey times on key routes have been considered in order to determine the traffic impacts on the strategic road network.

The results from this analysis are presented in **Section 6.6.3**.

6.6.1.2 Network Statistics

To further quantify the impact of the proposed road development on the strategic road network the model network statistics are assessed. These statistics provide information on the following parameters (averaged across the entire city network):

- Average Speed – Measured in kilometres per hour (kph)
- Average Delay – Measured in total delay for all vehicles
- Total Network Travel Time – Measures in total travel time for all vehicles
- Total Vehicle Distance Travelled – Measured in total kilometres for all vehicles

This KPI therefore presents an indication of the overall performance of the model network for a given scenario.

As there are several related parameters to consider for this criterion, and in order to avoid confusion, this KPI is measured in absolute terms. i.e. there is either a positive or negative impact on overall network statistics.

This analysis is presented at **Section 6.6.3**.

6.6.1.3 Ratio of Flow to Capacity at Key Junctions

To further understand the potential impact on junction operations of the proposed road development, the Ratio (of traffic flow) over capacity (RFC) at key junctions along the existing N6 corridor have been analysed and compared across scenarios.

RFC is a standard reference for measuring traffic congestion at a junction. It is standard practice to consider that a junction is congested when traffic flows are at 85% of the estimated capacity of a priority junction, or 90% of a signalised junction. At traffic flows above 90% of capacity the delays at a junction become erratic and are difficult to control. A value of 100% means that demand and capacity are equal and no further traffic can progress through the junction without experiencing delays.

A Ratio of Flow to Capacity analysis has been undertaken using information from the proposed road development Highway Network models for each modelling scenario. This analysis considered all approaches to key junctions along the N6/R338 corridor, illustrated in **Plate 6.8** below.

The models were also used to produce an overall summary of the number of links, in the entire network, operating at 90% capacity or above in each scenario.

Plate 6.8: N6/R338 Key Junctions

The scale of the impact is based on the threshold values described above and it is the change in these values arising from the impact of the proposed road development (Do Something) which indicates the extent of localised impact at the junctions assessed. – **Table 6.5**, below, refers to roundabouts and other priority junctions and **Table 6.6** refers to signalised junctions and summarises how the change in the value of these parameters indicates the performance impact.

Table 6.5: Impact on RFC at Key Junctions (Roundabout)

RFC	**Do Something**			
Do Minimum	<75%	75-85%	85-90%	>90%
<75%	Negligible	Moderate	Major	Major
75-85%	Positive	Minor	Moderate	Major
85-90%	Positive	Positive	Minor	Major
>90%	Positive	Positive	Positive	Minor

It is assumed that if a roundabout is currently operating well within capacity (e.g. <75%) and the additional traffic associated with the proposed road development causes the junction to be congested (i.e. over 85%) there is a traffic impact of major significance. Conversely if the junction currently has congestion issues (e.g. 85-90%) and the traffic from the proposed road development causes an increase in congestion, but within the same parameter value band (i.e. 85-90%) the impact of the proposed road development is considered to be of minor significance.

Table 6.6: Impact on RFC at Key Junctions (Signalised)

RFC	Do Something			
Do Minimum	<80%	80-90%	90-95%	>95%
<80%	Negligible	Moderate	Major	Major
80-90%	Positive	Minor	Moderate	Major
90-95%	Positive	Positive	Minor	Major
>95%	Positive	Positive	Positive	Minor

It is assumed that if a signalised junction is currently operating well within capacity (e.g. <80%) and the additional traffic associated with the proposed road development causes the junction to be congested (i.e. over 90%) the traffic impact is of major significance. However, if the junction currently has congestion issues (e.g. 90-95%) and the traffic from the proposed road development causes an increase in congestion, but within the same parameter value band (i.e. 90-95%) the impact on junction performance is considered to be minor significance, i.e. little change – still congested.

6.6.2 Rating Impacts

The impact of the proposed road development under each scenario is rated using the assessment KPI framework detailed above as follows:

- **Step 1:** The relative changes between the 'Do-Minimum' and 'Do-Something' scenarios are categorised as positive, negligible, minor, moderate or major (as above)
- **Step 2:** The likelihood of the negative impacts occurring are rated as either low, medium or high
- **Step 3:** The duration of negative impacts is rated as short, medium or long term. As per EPA guidelines, short-term equates to 1-7 years, medium term is between 7 and 15 years and long term is between 15 and 60 years

This method of rating impacts allows the 'Do-Minimum' and 'Do-Something' scenarios to be compared in a clear, concise and measurable way.

6.6.3 Significance of Impact Assessment

The results of the strategic and local traffic impacts for each scenario are described under each KPI below. In summary, the scenarios compared are:

- 2024 Opening Year Do-Minimum
- 2024 Opening Year Do-Something
- 2039 Design Year Do-Minimum
- 2039 Design Year Do-Something
- 2039 Design Year – Do GTS

The results presented in this section refer to the Medium Growth Forecasts only. The evaluation of Low and High growth sensitivity tests are summarised within **Section 6.7**.

6.6.3.1 Journey Time Analysis

Core Scenarios

The tables below detail the results of the journey time comparison as extracted from the 2024 and 2039 traffic models for the Core Scenarios. **Plate 6.7**, above illustrates each of the journey time routes which have been analysed.

Table 6.7: 2024 AM Peak Journey Time Results

Route Description	2024 DM Seconds	2024 DM Minutes	2024 DS Seconds	2024 DS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	1050	17.5	778	13.0	-272	-25.9%
Route 1 – Outbound	684	11.4	680	11.3	-4	-0.6%
Route 2 – Inbound	1334	22.2	1183	19.7	-151	-11.3%
Route 2 – Outbound	1196	19.9	1222	20.4	26	0%
Route 3 – Inbound	433	7.2	305	5.1	-128	-29.6%
Route 3 – Outbound	259	4.3	266	4.4	7	2.7%
Route 4a – Inbound	725	12.1	669	11.2	-56	-7.7%
Route 4a – Outbound	804	13.4	678	11.3	-126	-15.7%
Route 4B – Inbound	1070	17.8	684	11.4	-386	-36.1%
Route 4B – Outbound	1065	17.8	704	11.7	-361	-33.9%
Route 5 – Inbound	1118	18.6	967	16.1	-151	-13.5%
Route 5 – Outbound	1159	19.3	1008	16.8	-151	-13.0%
Route 6 – Inbound	1077	18.0	1177	19.6	100	9.3%
Route 6 – Outbound	944	15.7	959	16.0	15	1.6%
Route 7 – Inbound	1358	22.6	1220	20.3	-138	-10.2%
Route 7 – Outbound	1264	21.1	1214	20.2	-50	-4.0%
Route 8 – Inbound	820	13.7	801	13.4	-19	-2.3%
Route 8 – Outbound	603	10.1	605	10.1	2	0.3%
Route 9 – Inbound	360	6.0	359	6.0	-1	-0.3%
Route 9 – Outbound	360	6.0	358	6.0	-2	-0.6%
Route 10 – Inbound	571	9.5	470	7.8	-101	-17.7%
Route 10 – Outbound	666	11.1	505	8.4	-161	-24.2%
Route 11 – Inbound	1292	21.5	972	16.2	-320	-24.8%
Route 11 – Outbound	1048	17.5	858	14.3	-190	-18.1%

Table 6.8: 2024 IP 1 Journey Time Results

Route Description	2024 DM Seconds	2024 DM Minutes	2024 DS Seconds	2024 DS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	695	11.6	674	11.2	-21	-3.0%
Route 1 – Outbound	662	11.0	655	10.9	-7	-1.1%
Route 2 – Inbound	1047	17.5	1122	18.7	75	7.2%
Route 2 – Outbound	1106	18.4	1139	19.0	33	3.0%
Route 3 – Inbound	288	4.8	292	4.9	4	1.4%
Route 3 – Outbound	258	4.3	266	4.4	8	3.1%
Route 4a – Inbound	644	10.7	607	10.1	-37	-5.7%
Route 4a – Outbound	687	11.5	650	10.8	-37	-5.4%
Route 4b – Inbound	597	10.0	610	10.2	13	2.2%
Route 4b – Outbound	840	14.0	552	9.2	-288	-34.3%
Route 5 – Inbound	924	15.4	892	14.9	-32	-3.5%
Route 5 – Outbound	1088	18.1	959	16.0	-129	-11.9%
Route 6 – Inbound	960	16.0	980	16.3	20	0
Route 6 – Outbound	924	15.4	947	15.8	23	2.5%
Route 7 – Inbound	1053	17.6	1026	17.1	-27	-2.6%
Route 7 – Outbound	1245	20.8	1152	19.2	-93	-7.5%
Route 8 – Inbound	629	10.5	664	11.1	35	5.6%
Route 8 – Outbound	603	10.1	630	10.5	27	4.5%
Route 9 – Inbound	358	6.0	358	6.0	0	0.0%
Route 9 – Outbound	359	6.0	358	6.0	-1	-0.3%
Route 10 – Inbound	415	6.9	433	7.2	18	4.3%
Route 10 – Outbound	437	7.3	439	7.3	2	0.5%
Route 11 – Inbound	821	13.7	741	12.4	-80	-9.7%
Route 11 – Outbound	951	15.9	844	14.1	-107	-11.3%

Table 6.9: 2024 IP 2 Journey Time Results

Route Description	2024 DM Seconds	2024 DM Minutes	2024 DS Seconds	2024 DS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	730	12.2	680	11.3	-50	-6.8%
Route 1 – Outbound	683	11.4	659	11.0	-24	-3.55
Route 2 – Inbound	1076	17.9	1145	19.1	69	6.4%
Route 2 – Outbound	1139	19.0	1165	19.2	15	1.3%
Route 3 – Inbound	290	4.8	294	4.9	4	1.4%
Route 3 – Outbound	259	4.3	267	4.5	8	3.1%
Route 4a – Inbound	661	11.0	610	10.2	-51	-7.7%
Route 4a – Outbound	712	11.9	651	10.9	-61	-8.6%
Route 4b – Inbound	638	10.6	604	10.1	-34	-5.3%
Route 4b – Outbound	1078	18.0	569	9.5	-509	-47.2%
Route 5 – Inbound	963	16.1	893	14.9	-70	-7.3%
Route 5 – Outbound	1183	19.7	991	16.5	-192	-16.2%
Route 6 – Inbound	1047	17.5	1009	16.8	-38	-3.6%
Route 6 – Outbound	969	16.2	981	16.4	12	1.2%
Route 7 – Inbound	1101	18.4	1030	17.2	-71	-6.4%
Route 7 – Outbound	1421	23.7	1226	20.4	-195	-13.7%
Route 8 – Inbound	628	10.5	651	10.9	23	3.7%
Route 8 – Outbound	662	11.0	679	11.3	17	2.6%
Route 9 – Inbound	358	6.0	358	6.0	0	0.0%
Route 9 – Outbound	360	6.0	358	6.0	-2	-0.6%
Route 10 – Inbound	424	7.1	476	7.9	52	12.3%
Route 10 – Outbound	463	7.7	445	7.4	-18	-3.9%
Route 11 – Inbound	828	13.8	736	12.3	-92	-11.1%
Route 11 – Outbound	1183	19.7	932	15.5	-251	-21.2%

Table 6.10: 2024 PM Journey Time Results

Route Description	2024 DM Seconds	2024 DM Minutes	2024 DS Seconds	2024 DS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	715	11.9	688	11.5	-27	-3.8%
Route 1 – Outbound	717	12.0	673	11.2	-44	-6.15
Route 2 – Inbound	1137	19.0	1222	20.4	85	7.5%
Route 2 – Outbound	1163	19.4	1179	19.7	16	1.4%
Route 3 – Inbound	290	4.8	294	4.9	4	1.4%
Route 3 – Outbound	259	4.3	267	4.5	8	3.1%
Route 4a – Inbound	754	12.6	648	10.8	-106	-14.1%
Route 4a – Outbound	789	13.2	685	11.4	-104	-13.2%
Route 4b – Inbound	716	11.9	627	10.5	-89	-12.4%
Route 4b – Outbound	1154	19.2	644	10.7	-510	-44.2%
Route 5 – Inbound	1128	18.8	1004	16.7	-124	-11.0%
Route 5 – Outbound	1160	19.3	1040	17.3	-120	-10.3%
Route 6 – Inbound	1093	18.2	1020	17.0	-73	-6.7%
Route 6 – Outbound	1006	16.8	1030	17.2	24	2.4%
Route 7 – Inbound	1141	19.0	1061	17.7	-80	-7.0%
Route 7 – Outbound	1495	24.9	1313	21.9	-182	-12.2%
Route 8 – Inbound	619	10.3	633	10.6	14	2.3%
Route 8 – Outbound	797	13.3	838	14.0	41	5.1%
Route 9 – Inbound	359	6.0	359	6.0	0	0.0%
Route 9 – Outbound	360	6.0	359	6.0	-1	-0.3%
Route 10 – Inbound	510	8.5	424	7.1	-86	-16.9%
Route 10 – Outbound	491	8.2	476	7.9	-15	-3.1%
Route 11 – Inbound	851	14.2	736	12.3	-115	-13.5%
Route 11 – Outbound	1325	22.1	1023	17.1	-302	-22.8%

The 2024 AM Peak results above show that, in general, the opening of the proposed road development has a significant positive impact on the majority of Journey Time routes analysed.

A number of routes (2, 3, 6) show negligible impacts, with increases in journey times of less than 60 seconds across the entire route. Route 6 inbound experiences a minor impact, where the journey time has increased by 100 seconds across the entire route. These increases are caused by the addition of signalised junctions, for example the N59 Link Road Junctions, which require traffic to slow down where previously it was not necessary.

In this regard it should be noted that the impact of the proposed road development is hugely beneficial for reducing traffic congestion in Galway City in the AM Peak and for reducing journey times.

The 2024 PM Peak results show that, similar to the AM peak, the opening of the proposed road development has a significantly positive impact on the majority of Journey Time routes analysed.

As with the AM peak number of routes show negligible or minor impacts, with relatively small (less than 2 minute) increases across the entire route. These increases are as a result of new signalised junctions, related to the proposed road development, requiring traffic to slow down where previously it was not necessary.

The introduction of the proposed road development reduces traffic congestion and average journey times in Galway City in the PM Peak.

Journey time results for the inter peak periods demonstrate the same pattern as the AM and PM peaks, with positive impacts seen across the majority of routes analysed. Any increases in journey times are negligible in nature.

Table 6.11: 2039 AM Peak Journey Time Results

Route Description	2039 DM Seconds	2039 DM Minutes	2039 DS Seconds	2039 DS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	1107	18.6	841	13.2	-266	-24.0%
Route 1 – Outbound	688	11.6	680	11.4	-8	-1.2%
Route 2 – Inbound	1376	23.0	1209	20.3	-167	-12.1%
Route 2 – Outbound	1221	20.5	1255	21.7	34	0
Route 3 – Inbound	465	8.0	315	5.3	-150	-32.3%
Route 3 – Outbound	259	4.3	267	4.5	8	3.1%
Route 4a – Inbound	729	12.2	680	11.5	-49	-6.7%
Route 4a – Outbound	827	15.9	683	11.4	-144	-17.4%
Route 4b – Inbound	1212	21.1	770	13.8	-442	-36.5%
Route 4b – Outbound	1105	20.0	707	11.9	-398	-36.0%
Route 5 – Inbound	1268	23.3	1016	17.9	-252	-19.9%
Route 5 – Outbound	1182	22.1	1029	18.4	-153	-12.9%
Route 6 – Inbound	1089	18.1	1110	18.8	21	1.9%
Route 6 – Outbound	956	15.9	978	16.4	22	2.3%
Route 7 – Inbound	1502	27.3	1270	22.5	-232	-15.4%
Route 7 – Outbound	1321	24.2	1257	20.9	-64	-4.8%
Route 8 – Inbound	952	18.7	846	16.7	-106	-11.1%
Route 8 – Outbound	609	10.9	611	9.9	2	0.3%
Route 9 – Inbound	361	6.0	359	6.0	-2	-0.6%
Route 9 – Outbound	360	6.0	358	6.0	-2	-0.6%
Route 10 – Inbound	593	11.1	487	7.6	-106	-17.9%
Route 10 – Outbound	667	11.9	511	16.9	-156	-23.4%
Route 11 – Inbound	1495	27.1	1061	18.5	-434	-29.0%
Route 11 – Outbound	1109	20.9	895	15.8	-214	-19.3%

Table 6.12: 2039 IP 1 Journey Time Results

Route Description	2039 DM Seconds	2039 DM Minutes	2039 DS Seconds	2039 DS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	712	11.9	679	11.3	-33	-4.6%
Route 1 – Outbound	667	11.1	657	11.0	-10	-1.5%
Route 2 – Inbound	1057	17.6	1129	18.8	73	6.9%
Route 2 – Outbound	1114	18.6	114+6	19.1	32	2.9%
Route 3 – Inbound	289	4.8	293	4.9	4	1.4%
Route 3 – Outbound	258	4.3	266	4.4	8	3.1%
Route 4a – Inbound	664	11.1	613	10.2	-51	-7.7%
Route 4a – Outbound	700	11.7	653	10.9	-47	-6.7%
Route 4b – Inbound	639	10.7	617	10.3	-22	-3.4%
Route 4b – Outbound	958	16.0	571	9.5	-387	-40.4%
Route 5 – Inbound	968	16.1	902	15.0	-66	-6.8%
Route 5 – Outbound	1162	19.4	988	16.5	-174	-15.0%
Route 6 – Inbound	964	16.1	989	16.5	25	2.6%
Route 6 – Outbound	930	15.5	962	16.0	32	3.4%
Route 7 – Inbound	1073	17.9	1046	17.4	-27	-2.5%
Route 7 – Outbound	1456	24.3	1207	20.1	-249	-17.1%
Route 8 – Inbound	638	10.6	690	11.5	52	8.2%
Route 8 – Outbound	618	10.3	657	11.0	39	6.3%
Route 9 – Inbound	358	6.0	358	6.0	0	0.0%
Route 9 – Outbound	360	6.0	358	6.0	-2	-0.6%
Route 10 – Inbound	415	6.9	435	7.3	20	4.8%
Route 10 – Outbound	439	7.3	438	7.3	-1	-0.2%
Route 11 – Inbound	880	14.7	800	13.3	-80	-9.1%
Route 11 – Outbound	1064	17.7	900	15.0	-164	-15.4%

Table 6.13: 2039 IP 2 Journey Time Results

Route Description	2039 DM Seconds	2039 DM Minutes	2039 DS Seconds	2039 DS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	730	12.2	686	11.4	-44	-6.0%
Route 1 – Outbound	683	11.4	661	11.0	-22	-3.2%
Route 2 – Inbound	1076	17.9	1165	19.4	89	8.3%
Route 2 – Outbound	1139	190.	1161	19.4	22	1.9%
Route 3 – Inbound	290	4.8	295	4.9	5	1.7%
Route 3 – Outbound	259	4.3	267	4.5	8	3.1%
Route 4a – Inbound	661	11.0	615	10.3	-46	-7.0%
Route 4a – Outbound	712	11.9	655	10.9	-57	-8.0%
Route 4b – Inbound	638	10.6	619	10.3	-19	-3.0%
Route 4b – Outbound	1078	18.0	594	9.9	-484	-44.9%
Route 5 – Inbound	963	16.1	903	15.1	-60	-6.2%
Route 5 – Outbound	1183	19.7	1028	17.1	-155	-13.1%
Route 6 – Inbound	1047	17.5	1024	17.1	-23	-2.2%
Route 6 – Outbound	969	16.2	1016	16.9	47	4.9%
Route 7 – Inbound	1101	18.4	1048	17.5	-53	-4.8%
Route 7 – Outbound	1421	23.7	1261	21.0	-160	-11.3%
Route 8 – Inbound	628	10.5	672	11.2	44	7.0%
Route 8 – Outbound	662	11.0	694	11.6	32	4.8%
Route 9 – Inbound	358	6.0	358	6.0	0	0.0%
Route 9 – Outbound	360	6.0	359	6.0	-1	-0.3%
Route 10 – Inbound	424	7.1	469	7.8	45	10.6%
Route 10 – Outbound	463	7.7	444	7.4	-19	-4.1%
Route 11 – Inbound	828	13.8	786	13.1	-42	-5.1%
Route 11 – Outbound	1183	19.7	998	16.6	-185	-15.6%

Table 6.14: 2039 PM Peak Journey Time Results

Route Description	2039 DM Seconds	2039 DM Minutes	2039 DS Seconds	2039 DS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	731	12.2	691	11.5	-40	-5.5%
Route 1 – Outbound	738	12.3	677	11.3	-61	-8.3%
Route 2 – Inbound	1189	19.8	1308	21.8	119	10.0%
Route 2 – Outbound	1190	19.8	1183	19.7	-7	-0.6%
Route 3 – Inbound	291	4.9	295	4.9	4	1.4%
Route 3 – Outbound	259	4.3	268	4.5	9	3.5%
Route 4a – Inbound	790	13.2	685	11.4	-105	-13.3%
Route 4a – Outbound	1557	26.0	689	11.5	-868	-55.7%
Route 4b – Inbound	772	12.9	633	10.6	-139	-18.0%
Route 4b – Outbound	779	13.0	688	11.5	-91	-11.7%
Route 5 – Inbound	1189	19.8	1020	17.0	-169	-14.2%
Route 5 – Outbound	1271	21.2	1070	17.8	-201	-15.8%
Route 6 – Inbound	1097	18.3	1040	17.3	-57	-5.2%
Route 6 – Outbound	1027	17.1	1080	18.0	53	5.2%
Route 7 – Inbound	1169	19.5	1063	1.7	-106	-9.1%
Route 7 – Outbound	1663	27.7	1440	24.0	-223	-13.4%
Route 8 – Inbound	624	10.4	638	10.6	14	2.2%
Route 8 – Outbound	899	15.0	918	15.3	19	2.1%
Route 9 – Inbound	359	6.0	359	6.0	0	0.0%
Route 9 – Outbound	361	6.0	360	6.0	-1	-0.3%
Route 10 – Inbound	598	10.0	424	7.1	-174	-29.1%
Route 10 – Outbound	534	8.9	489	8.2	-45	-8.4%
Route 11 – Inbound	946	15.8	761	12.7	-185	-19.6%
Route 11 – Outbound	1620	27.0	1124	18.7	-496	-30.6%

The 2039 results show a similar pattern to the 2024 results discussed previously. In general, the opening of the proposed road development has a significantly positive impact on the majority of Journey Time routes analysed in all 2039 modelled periods for the Core Scenarios.

A small number of routes show negligible or minor impacts, with increases in journey times of less than 120 seconds across the entire route. These increases are caused by the addition of new signalised junctions, requiring traffic to slow down where previously it was not necessary.

GTS Sensitivity Test

The tables below outline the results of the journey time comparison as extracted from the traffic model for the 2039 Galway Transport Strategy Sensitivity Test.

These results show a similar pattern to the Core Scenario tests discussed above. In general, the opening of the proposed road development, in conjunction with the other measures proposed in the GTS, has a positive impact on the majority of Journey Time routes analysed, particularly in the AM and PM peak periods.

The results below show more negative impacts on journey times than the DS Core Scenario tests. The reason for this is that the GTS contains a number of proposals which limit vehicular capacity on the city centre network, as a result of increased active mode and public transport priority measures in the city centre, and therefore adds delay to certain sections of the network. Also, traffic management arrangements proposed in the GTS result in the lengthening of some journey time routes which in turn adds to the total journey times.

Table 6.15: 2039 GTS AM Peak Journey Time Results

Route Description	2039 DM Seconds	2039 DM Minutes	2039 GTS Seconds	2039 GTS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	1107	18.6	900	15.0	-207	-18.7%
Route 1 – Outbound	688	11.6	685	11.4	-3	-0.4%
Route 2 – Inbound	1376	23.0	1245	20.8	-131	-9.5%
Route 2 – Outbound	1221	20.5	1421	23.7	200	16.4%
Route 3 – Inbound	465	8.0	411	6.9	-54	-11.6%
Route 3 – Outbound	259	4.3	427	7.1	168	64.9%
Route 4a – Inbound	729	12.2	682	11.4	-47	-6.4%
Route 4a – Outbound	827	15.9	724	12.1	-103	-12.5%
Route 4b – Inbound	1212	21.1	767	12.8	-445	-36.7%
Route 4b – Outbound	1105	20.0	662	11.0	-443	-40.1%
Route 5 – Inbound	1268	23.3	1063	17.7	-205	-16.2%
Route 5 – Outbound	1182	22.1	1176	19.6	-6	-0.5%
Route 6 – Inbound	1089	18.1	1066	17.8	-23	0
Route 6 – Outbound	956	15.9	1009	16.8	53	5.5%
Route 7 – Inbound	1502	27.3	1237	20.6	-265	-17.6%
Route 7 – Outbound	1321	24.2	1270	21.2	-51	-3.9%
Route 8 – Inbound	952	18.7	935	15.6	-17	-1.8%
Route 8 – Outbound	609	10.9	635	10.6	26	4.3%
Route 9 – Inbound	361	6.0	359	6.0	-2	-0.6%
Route 9 – Outbound	360	6.0	358	6.0	-2	-0.6%
Route 10 – Inbound	593	11.1	481	8.0	-112	-18.9%
Route 10 – Outbound	667	11.9	715	11.9	48	7.2%
Route 11 – Inbound	1495	27.1	1008	16.8	-487	-32.6%
Route 11 – Outbound	1109	20.9	903	15.1	-206	-18.6%

Table 6.16: 2039 GTS IP 1 Journey Time Results

Route Description	2039 DM Seconds	2039 DM Minutes	2039 GTS Seconds	2039 GTS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	712	11.9	702	11.7	-10	-1.4%
Route 1 – Outbound	667	11.1	676	11.3	9	1.3%
Route 2 – Inbound	1056	17.6	1216	20.3	160	15.2%
Route 2 – Outbound	1114	18.6	1260	21.0	146	13.1%
Route 3 – Inbound	289	4.8	403	6.7	114	39.4%
Route 3 – Outbound	258	4.3	427	7.1	169	65.5%
Route 4a – Inbound	664	11.1	635	10.6	-29	-4.4%
Route 4a – Outbound	700	11.7	687	11.5	-13	-1.9%
Route 4b – Inbound	639	10.7	602	10.0	-37	-5.8%
Route 4b – Outbound	958	16.0	628	10.5	-330	-34.4%
Route 5 – Inbound	968	16.1	1018	17.0	50	5.2%
Route 5 – Outbound	1162	19.4	1187	19.8	25	2.2%
Route 6 – Inbound	964	16.1	1009	16.8	45	4.7%
Route 6 – Outbound	930	15.5	1028	17.1	98	10.5%
Route 7 – Inbound	1073	17.9	1038	17.3	-35	-3.3%
Route 7 – Outbound	1456	24.3	1257	21.0	-199	-13.7%
Route 8 – Inbound	638	10.6	688	11.5	50	7.8%
Route 8 – Outbound	618	10.3	702	11.7	84	13.6%
Route 9 – Inbound	358	6.0	358	6.0	0	0.0%
Route 9 – Outbound	360	6.0	358	6.0	-2	-0.6%
Route 10 – Inbound	415	6.9	417	7.0	2	0.5%
Route 10 – Outbound	439	7.3	448	7.5	9	2.1%
Route 11 – Inbound	880	14.7	854	14.2	-26	-3.0%
Route 11 – Outbound	1064	17.7	885	14.8	-179	-16.8%

Table 6.17: 2039 GTS IP 2 Journey Time Results

Route Description	2039 DM Seconds	2039DM Minutes	2039 GTS Seconds	2039 GTS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	730	12.2	721	12.0	-9	-1.2%
Route 1 – Outbound	683	11.4	696	11.6	13	1.9%
Route 2 – Inbound	1076	17.9	1251	20.9	175	16.3%
Route 2 – Outbound	1139	19.0	1276	21.3	137	12.0%
Route 3 – Inbound	290	4.8	406	6.8	116	40.0%
Route 3 – Outbound	259	4.3	427	7.1	168	64.9%
Route 4a – Inbound	661	11.0	636	10.6	-25	-3.8%
Route 4a – Outbound	712	11.9	687	11.5	-25	-3.5%
Route 4b – Inbound	638	10.6	607	10.1	-31	-4.9%
Route 4b – Outbound	1078	18.0	633	10.6	-445	-41.3%
Route 5 – Inbound	963	16.1	1027	17.1	65	6.7%
Route 5 – Outbound	1183	19.7	1228	20.5	45	3.8%
Route 6 – Inbound	1047	17.5	1049	17.5	2	0.2%
Route 6 – Outbound	969	16.2	1076	17.9	107	11.0%
Route 7 – Inbound	1101	18.4	1047	17.5	-54	-4.9%
Route 7 – Outbound	1421	23.7	1372	22.9	-49	-3.4%
Route 8 – Inbound	628	10.5	681	11.4	53	8.4%
Route 8 – Outbound	662	11.0	756	12.6	94	14.2%
Route 9 – Inbound	358	6.0	358	6.0	0	0.0%
Route 9 – Outbound	360	6.0	358	6.0	-2	-0.6%
Route 10 – Inbound	424	7.1	418	7.0	-6	-1.4%
Route 10 – Outbound	463	7.7	453	7.6	-10	-2.2%
Route 11 – Inbound	828	13.8	917	15.3	89	10.7%
Route 11 – Outbound	1183	19.7	978	16.3	-205	-17.3%

Table 6.18: 2039 GTS PM Peak Journey Time Results

Route Description	2039 DM Seconds	2039 DM Minutes	2039 GTS Seconds	2039 GTS Minutes	Diff (Seconds)	% Difference
Route 1 – Inbound	731	12.2	711	11.9	-20	-2.7%
Route 1 – Outbound	738	12.3	707	11.8	-31	-4.2%
Route 2 – Inbound	1189	19.8	1388	23.1	199	16.7%
Route 2 – Outbound	1190	19.8	1354	22.6	164	13.8%
Route 3 – Inbound	291	4.9	407	6.8	116	39.9%
Route 3 – Outbound	259	4.3	429	7.2	170	65.6%
Route 4a – Inbound	790	13.2	713	11.9	-77	-9.7%
Route 4a – Outbound	157	26.0	728	12.1	-829	-53.2%
Route 4b – Inbound	772	12.9	607	10.1	-165	-21.4%
Route 4b – Outbound	779	13.0	699	11.7	-80	-10.3%
Route 5 – Inbound	1189	19.8	1063	17.7	-126	-10.6%
Route 5 – Outbound	1271	21.2	1325	22.1	54	4.2%
Route 6 – Inbound	1097	18.3	1015	16.9	-82	-7.5%
Route 6 – Outbound	1027	17.1	1168	19.5	141	13.7%
Route 7 – Inbound	1169	19.5	1050	17.5	-119	-10.2%
Route 7 – Outbound	1663	27.7	1629	27.2	-34	-2.0%
Route 8 – Inbound	624	10.4	669	11.2	45	7.2%
Route 8 – Outbound	899	15.0	873	14.6	-26	-2.9%
Route 9 – Inbound	359	6.0	359	6.0	0	0.0%
Route 9 – Outbound	361	6.0	359	6.0	-2	-0.6%
Route 10 – Inbound	598	10.0	509	8.5	-89	-14.9%
Route 10 – Outbound	534	8.9	557	9.3	23	4.3%
Route 11 – Inbound	946	15.8	859	14.3	-87	-9.2%
Route 11 – Outbound	1620	27.0	1070	17.8	-550	-34.0%

6.6.3.2 Network Statistics (2024 and 2039)

The tables below present Network Statistics from each modelled time-period for all medium growth scenarios.

Table 6.19: Network Performance Indicators – Morning Peak Hour

Scenario	Total Vehicle Distance (pcu. Kms)	Total Network Travel Time (pcu. Hrs)	Total Network Delay (pcu. Hrs)	Average Vehicle Speed (kph)	Impact
2024 Do-Minimum	223,666	7,576	2,274	29.5	-
2024 Do-Something	258,719	6,798	1,505	38.1	Positive
2039 Do-Minimum	247,788	8,619	2,812	28.7	-
2039 Do-Something	294,178	7,611	1,738	38.7	Positive
2039 Galway Strategy	294,497	7,756	1,810	38	Positive

Table 6.20: Network Performance Indicators – IP 1

Scenario	Total Vehicle Distance (pcu. Kms)	Total Network Travel Time (pcu. Hrs)	Total Network Delay (pcu. Hrs)	Average Vehicle Speed (kph)	Impact
2024 Do-Minimum	148,147	4,321	920	34.3	-
2024 Do-Something	163,308	4,144	767	39.4	Positive
2039 Do-Minimum	171,081	5,039	1,171	33.9	-
2039 Do-Something	190,786	4,750	916	40.2	Positive
2039 Galway Strategy	192,388	4,932	1,009	39	Positive

Table 6.21: Network Performance Indicators – IP 2

Scenario	Total Vehicle Distance (pcu. Kms)	Total Network Travel Time (pcu. Hrs)	Total Network Delay (pcu. Hrs)	Average Vehicle Speed (kph)	Impact
2024 Do-Minimum	173,045	5,164	1,124	33.5	-
2024 Do-Something	192,752	5,023	980	38.4	Positive
2039 Do-Minimum	196,764	5,929	1,403	33.2	-
2039 Do-Something	223,715	5,731	1,189	39	Positive
2039 Galway Strategy	224,131	5,910	1,292	37.9	Positive

Table 6.22: Network Performance Indicators – Evening peak Hour

Scenario	Total Vehicle Distance (pcu. Kms)	Total Network Travel Time (pcu. Hrs)	Total Network Delay (pcu. Hrs)	Average Vehicle Speed (kph)	Impact
2024 Do-Minimum	206,659	6,669	1,824	31	-
2024 Do-Something	233,756	6,135	1,318	38.1	Positive
2039 Do-Minimum	230,010	7,774	2,453	29.6	-
2039 Do-Something	264,746	6,919	1,593	38.3	Positive
2039 Galway Strategy	266,632	7,128	1,720	37.4	Positive

The tables above demonstrate that the Do-Something (with proposed road development) option reduces the network delay considerably relative to the Do-Minimum, and provides a higher average speed in all time periods in both the Opening and Design Year. The reduction in delay allows traffic to travel further in a shorter period of time, which is illustrated in the increase in vehicle Km's and decrease in Total Travel time in all Do-Something Scenarios.

Analysis of the Galway Transport Strategy (GTS) scenario results indicate an increased level of delay and slightly lower average speeds compared to the "Do-Something" scenario of the same year. This increase in vehicular delay is caused by the proposed implementation of a number of active mode and public transport priority proposals contained within the GTS (e.g. converting the Salmon Weir Bridge to Public Transport Only) which result in decreased highway capacity for general vehicular traffic in Galway City Centre, which is in line with the objectives of the GTS. The level of network delay observed in this scenario is much lower than in the Do-Minimum Scenario of the same year. As with the Core Scenarios this is a result of the proposed road development relieving congestion in the City Centre.

This analysis indicates that the proposed road development will have a significantly positive impact in both Opening and Design Years.

Core Scenarios

The tables below summarise the junction evaluations for the 2024 and 2039 - Medium Growth Scenarios.

Table 6.23: Number of Junction approaches at or over capacity - AM Peak

		2024			2039		
		DM	**DS**	**Impact**	**DM**	**DS**	**Impact**
Key Junctions (N6 / R338)	RFC > 90%	15	9	Positive	18	12	Positive
Entire Network	RFC > 90%	151	78	Positive	200	115	Positive

Table 6.24: Number of Junction approaches at or over capacity - IP 1

		2024			2039		
		DM	**DS**	**Impact**	**DM**	**DS**	**Impact**
Key Junctions (N6 / R338)	RFC > 90%	6	2	Positive	9	5	Positive
Entire Network	RFC > 90%	28	12	Positive	60	26	Positive

Table 6.25: Number of Junction approaches at or over capacity - IP 2

		2024			2039		
		DM	**DS**	**Impact**	**DM**	**DS**	**Impact**
Key Junctions (N6 / R338)	RFC > 90%	8	4	Positive	11	5	Positive
Entire Network	RFC > 90%	53	29	Positive	81	49	Positive

Table 6.26: Number of Junction approaches at or over capacity - PM Peak

		2024			2039		
		DM	**DS**	**Impact**	**DM**	**DS**	**Impact**
Key Junctions (N6 / R338)	RFC > 90%	17	4	Positive	20	6	Positive
Entire Network	RFC > 90%	139	62	Positive	193	100	Positive

The above tables show that with the introduction of the proposed road development there is a large decrease in the number of links in the network which have an RFC of over 90%. This is particularly evident in the PM peak period where the number of over-capacity links, at key junctions along the N6/ R338 Corridor, reduces by over 70% in both 2024 and 2039. Similarly, the number of over-capacity links on the entire city network is reduced by 55% and 48% in 2024 and 2039, respectively, as a result of the introduction of the proposed road development.

GTS Sensitivity Test

The tables below summarise the junction evaluations for the 2039 - Medium Growth – Galway Transport Strategy (GTS).

Table 6.27: Number of Junction approaches at or over capacity - AM Peak

		2024			2039		
		DM	GTS	Impact	DM	GTS	Impact
Key Junctions (N6 / R338)	RFC > 90%	N/A	N/A	Positive	18	8	Positive
Entire Network	RFC > 90%	N/A	N/A	Positive	200	131	Positive

Table 6.28: Number of Junction approaches at or over capacity - IP 1

		2024			2039		
		DM	GTS	Impact	DM	GTS	Impact
Key Junctions (N6 / R338)	RFC > 90%	N/A	N/A	Positive	9	2	Positive
Entire Network	RFC > 90%	N/A	N/A	Positive	60	32	Positive

Table 6.29: Number of Junction approaches at or over capacity - IP 2

		2024			**2039**		
		DM	GTS	Impact	DM	GTS	Impact
Key Junctions (N6 / R338)	RFC > 90%	N/A	N/A	Positive	11	3	Positive
Entire Network	RFC > 90%	N/A	N/A	Positive	81	52	Positive

Table 6.30: Number of Junction approaches at or over capacity - PM Peak

		2024			**2039**		
		DM	GTS	Impact	DM	GTS	Impact
Key Junctions (N6 / R338)	RFC > 90%	N/A	N/A	Positive	20	6	Positive
Entire Network	RFC > 90%	N/A	N/A	Positive	193	123	Positive

The above tables show that, as with the Core Scenarios, the introduction of the Galway Transport Strategy proposals results in a decrease in the number of junctions operating above capacity within the entire city area and along the N6/R338 corridor.

In summary, the RFC analysis has shown that the introduction of the proposed road development will have a considerably positive impact on the key junctions in Galway City.

6.6.4 Assessment of Impact Significance

6.6.4.1 Impact Significance 2024

In 2024 the proposed road development does not result in any traffic impacts of major significance. In terms of the three key performance indicators used, the impact of the proposed road development is rated as having a positive impact.

6.6.4.2 Impact Significance 2039

In 2024 the proposed road development does not result in any traffic impacts of major significance. In terms of the three key performance indicators used, the impact of the proposed road development is rated as having a positive impact.

6.6.5 Construction Impacts

Construction traffic impacts, and associated mitigation measures, of the proposed road development are considered in detail in **Chapter 7, Construction Activities**.

Construction of the proposed road development will add additional traffic to the local networks for the duration of the construction works, as a result of materials supply and disposal, movement of site equipment and travel demand from site workers and visitors. The likelihood of these impacts are high but will be short-term in nature. Dedicated haulage routes were identified and are outlined in **Chapter 7, Construction Activities**.

Existing traffic movements on the local and regional road network will generally not be restricted by the proposed construction works. The proposed road development will ensure the minimum possible disturbance to local residents and existing traffic.

Night time working will be generally avoided, however, it will be necessary to work night shifts during certain critical stages during the project, such as for bridge works and road tie-in points. It is anticipated that, over the expected 36 month construction phase, there will be 10 weeks of night time working.

Existing cyclist and pedestrian movements will be facilitated throughout the construction period.

During construction, detailed traffic management plans in accordance with the mitigation measures and environmental measures set out in the EIAR and incorporating any specific additional requirements of statutory authorities and any conditions imposed by An Bord Pleanála, will clearly set out any temporary traffic restrictions.

6.6.6 Cumulative Impacts

6.6.6.1 Transport Schemes

As detailed in **Sections 6.4**, all core modelling scenarios (Do-Minimum and Do-Something) have taken into account committed transport schemes for Galway City and its environs and those likely to be completed for the various years assessed. The Galway Transport Strategy (GTS) sensitivity test, further analyses the cumulative impacts of complementary transport schemes by assessing the impacts of the proposed road development in conjunction with all of the Public Transport and Active Mode proposals contained within the GTS.

6.6.6.2 Transport Demand

Cumulative traffic volumes have been included in the analysis contained within this chapter through the use of travel demand forecasting. The proposed road development has been assessed in conjunction with three different travel demand scenarios (Low, Medium and High) designed to allow for a robust assessment of traffic growth in Galway over time resulting from increases in population and economic activity.

Further details on the cumulative impacts of traffic flows are detailed within **Chapter 16, Air Quality and Climate**, **Chapter 17, Noise and Vibration**, **Chapter 18, Human Beings, Population and Human Health** and **Chapter 19, Inter Relationships, Interactions, Cumulative Impacts and Other Impacts**.

6.6.6.3 Growth Forecast Sensitivity Tests

This section considers the potential implications on traffic impacts and mitigation requirements of variations in Growth Forecasts (i.e. from those assumed in the Core tests described above). This is done by way of sensitivity testing using the WRM and proposed road development Highway Network Models.

The sensitivity tests are listed below, whilst noting the definition of the basis of the Low and High growth is set out in **Section 6.2.3.2**:

- **Sensitivity Test 1:** 2024 & 2039 Low Growth Forecasts
- **Sensitivity Test 2:** 2024 & 2039 High Growth Forecasts

Sensitivity Test Impact Summary

In summary, there are no traffic impacts of major significance in either of the Low or High Growth Scenarios tested. As with the medium growth scenarios (discussed above) the proposed road development results in some negligible and minor impacts in terms of journey times due to the introduction of signalised junctions. However, the traffic impacts are positive and no mitigation measures are required.

6.7 Mitigation Measures

6.7.1 Construction Phase

As noted, the construction of the proposed road development will cause temporary short term traffic impacts on the local road network. The Construction Environmental Management Plan, included in **Appendix A.7.5** of this report, shall ensure that construction traffic impacts are minimised through the control of site access/ egress routes and site access locations.

6.7.2 Operational Phase

In summary, the traffic modelling indicates that for the Opening (2024) and Design (2039) Years there are no traffic impacts of major significance and therefore no mitigation measures are required.

However, as the proposed road development is a TEN-T route, which is required to cater for strategically important trips at an appropriate level of service, it will be important to protect the operating capacity of the proposed road development well into the future. To do this, measures to manage demand on the transport infrastructure, such as the integration of transport and land use planning, are considered within the development of the Galway Transport Strategy.

6.8 Residual Impacts

6.8.1 Construction Phase

With the implementation of the mitigation measures that have been identified, there will be no major impacts during the construction phase of the proposed road development.

6.8.2 Operational Phase

The proposed road development will see changes to the local, regional and national road network and traffic flows. The modelling work undertaken to assess the traffic impacts of the proposed road development indicates that there will be an overall positive traffic benefit associated with the proposed road development. Further, the proposed road development will provide benefits to existing and new public transport services and walking and cycling routes on the adjoining local and regional road network and other measures proposed by the Galway Transport Strategy.

Therefore, there are no residual negative traffic impacts anticipated.

6.8.3 Forecast Traffic Flows

6.8.3.1 AADT Forecasts

AADT estimates have been calculated using the N6 GCRR Traffic Model and in accordance with TII PAG Guidelines. To further demonstrate the benefits of the proposed road development and to help quantify the level of traffic redistribution which will occur as a result of the proposed road development, forecast traffic flows for the medium growth scenario are presented in this section.

Plate 6.9 illustrates the location of AADT points with corresponding AADT values shown in **Table 6.31**. A complete set of AADT data, including forecast flows for all sensitivity tests (Low, Medium, High) and further details on the methodology used to calculate AADTs, is available in the Traffic Modelling Report contained within **Appendix A.6.1**.

Table 6.31 illustrates that, in the 2039 medium growth scenario, there is significant demand for the proposed road development with AADTs in excess of 49,000 forecast for certain sections. This table also shows that traffic in the city centre is reduced as a result of the introduction of the proposed road development, as evidenced by the reduction in AADTs on Quincentenary Bridge (29% reduction).

Plate 6.9: Proposed Road Development AADT Locations

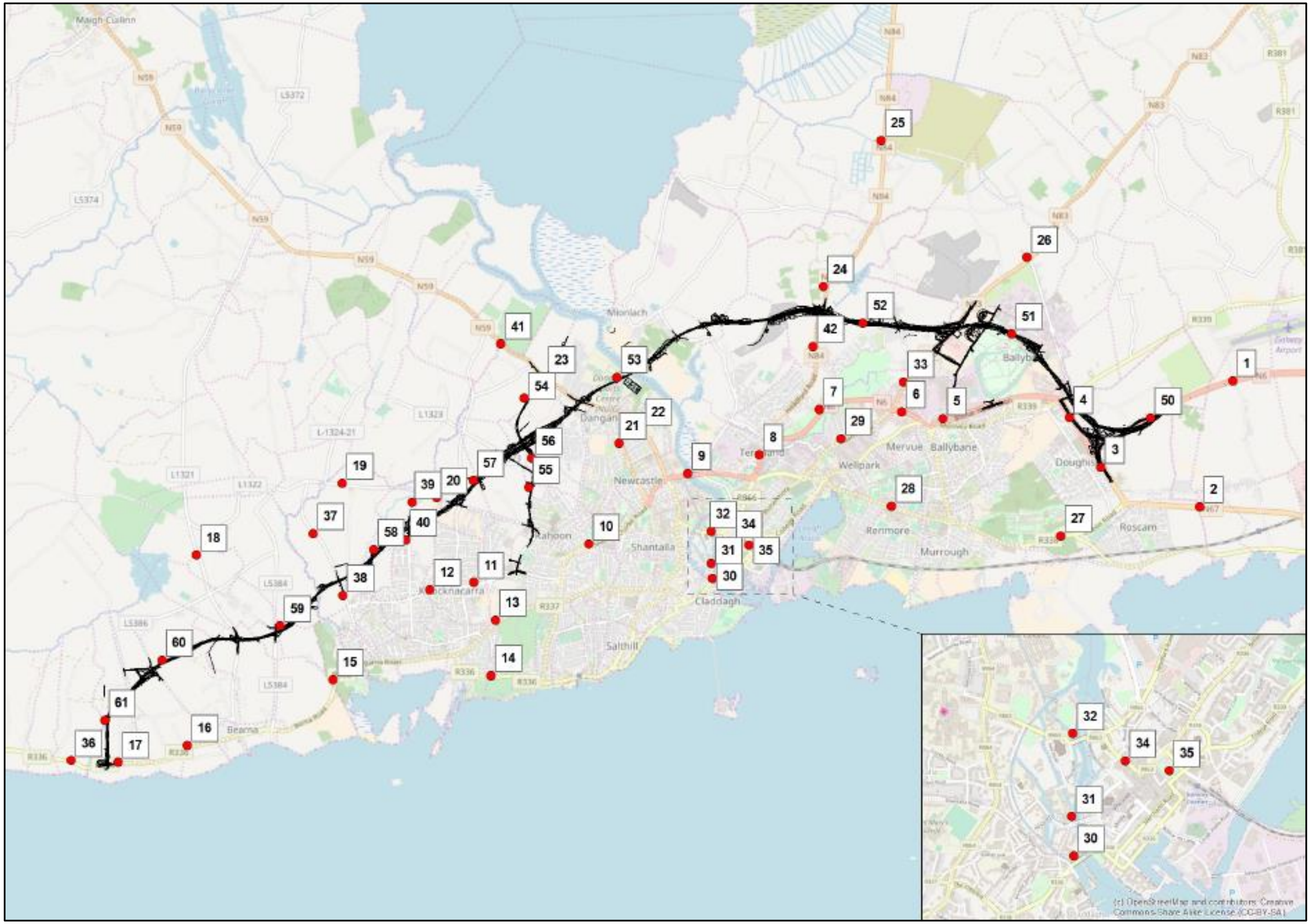


Table 6.31: Proposed Road Development AADT 2039 Design Year – Medium Growth

AADT Point	Location	2039 Do-Minimum Medium Growth		2039 GTS Medium Growth	
		AADT	%HGV	AADT	%HGV
1	N6 South of Galway Airport	23,382	8%	36,008	6%
2	R446 Westof Oranmore Business Park	22,588	10%	26,107	8%
3	R446 South of N6 Roundabout	18,807	7%	29,040	6%
4	N6 South of Briarhill	31,459	7%	18,862	6%
5	N6 Near Ballybrit Business Park	25,974	7%	15,553	5%
6	N6 Between N83 and R865	26,749	6%	18,766	3%
7	N6 Between N84 and N83	20,691	5%	11,307	4%
8	N6 East of Quincentenary Bridge	24,315	6%	23,215	5%
9	N6 On Quincentenary Bridge	34,546	7%	24,442	5%
10	R338 at Westside Playing fields	14,061	5%	7,556	1%
11	Western Distributor Road	11,657	2%	7,964	1%
13	R337 Kingston Road, Kingston	11,955	4%	7,148	0%
15	R336 Barna Road. Barna Woods	16,273	2%	4,313	0%
30	Wolfe Tone Bridge	18,074	4%	14,606	4%
31	O’Briens Bridge	9,725	4%	9,037	3%
32	Salmon Weir Bridge	17,910	1%	14,613	2%
36	R336 West of N6	10,875	3%	13,093	3%
41	N59-North of GCRR Link Road	17,749	2%	18,582	2%
42	N84 South of GCRR	14,298	6%	19,788	5%
50	N6 GCRR – Briarhill Junction			36,008	6%
51	N6 GCRR – Parkmore			38,705	5%
52	N6 GCRR – Between N83 and N84			49,876	5%
53	N6 GCRR – New Corrib Crossing			36,353	4%
54	N6 GCRR – N59 Lnk Road			11,530	4%
55	N6 GCRR – Rahoon Link Road			6,172	3%
56	N6 GCRR - Letteragh Link Road			13,709	3%
57	N6 GCRR – Ballymoneen to N59			20,920	3%
58	N6 GCRR – West of Ballymoneen			16,953	3%
60	N6 GCRR – At Truskey West			11,155	3%
61	N6 GCRR – North of Terminus			11,155	3%

6.8.3.2 Trip Redistribution and Overcapacity Demand

Induced traffic is the concept that car traffic grows to fill the available capacity of a road network.

The traffic modelling undertaken takes account of induced travel demand to varying degrees. The modelling results consider the redistribution effect of trips due to the introduction of new infrastructure and services (i.e. trip patterns changing because of lower costs of travel). It also takes account of re-routing of trips as a result of the provision of additional capacity on the network. The mode shift of trips from active modes and public transport to car (and vice versa) is also taken into account in the modelling results.

Induced development, is the phenomenon whereby new development is concentrated in the vicinity of high capacity transport corridors. The modelling undertaken for the proposed road development, takes account of forecast growth in the region as set out in local and regional plans (for low, medium and high growth scenarios), but does not include for the redistribution of growth that may occur along the corridor of the proposed road development.

It has been assumed that the forecast population and employment figures, and hence overall travel demand, will be the same in both the Do-Minimum and Do-Something Scenarios. These demographic forecasts have been agreed by Galway City and County Council and are based on the development plans for these areas which will not change with the opening of the proposed road development.

It is the role of the Planning Authorities to ensure that any development which could undermine the strategic function of the proposed road development will be appropriately mitigated. This may include the implementation of demand management measures to maintain the capacity and strategic function of the proposed road development.

Examination of the Do-Minimum and Do-Something traffic totals on the crossings of the River Corrib indicate that the proposed road development will lead to an increase of circa 19,000 AADT in 2039. It is important to highlight the fact that this increase is caused primarily by two factors:

1. The **redistribution of trips** with the opening of the proposed road development
2. **Release of overcapacity demand**[4] caused by congestion on the existing River Corrib crossings in the Do-Minimum network

Trip Redistribution

The introduction of the proposed road development reduces congestion on the River Corrib crossings leading to decreases in journey times from east to west across Galway City. The decrease in travel costs for these movements will result in a change in peoples living and working patterns in the city and its environs (e.g.

[4] Overcapacity demand refers to the difference between the desired trips and the actual trips undertaken.

potentially longer commuting patterns). This redistribution of trips contributes to the increase in cross city traffic described above.

Overcapacity Demand

In the Do-Minimum scenario, traffic congestion is at such a level that not all the trips which desire to cross the city (i.e. demand flow) can reach the River Corrib crossings in the assigned model periods. As actual flows (i.e. actual flows on the River Corrib crossing) are used to calculate the forecast AADT figures, the difference between demand flow and actual flow (which is known as the overcapacity demand) is not accounted for in the Do-minimum AADT figures. In the Do-something scenarios, demand flow and actual flows are closely aligned and therefore no overcapacity demand exists.

6.8.3.3 Galway Transport Strategy Forecasts

As outlined in **Section 6.4.3.2**, Galway County Council, Galway City Council, and the National Transport Authority have worked collaboratively in developing a multi-modal integrated transport strategy to resolve the existing transportation issues in Galway City and its environs. As a critical component of the overall transport solution for Galway, the proposed road development releases capacity in the city centre transport network and facilitates the implementation of key public transport and active mode proposals such as:

- A public transport corridor through the city centre with public transport only allowed on the Salmon Weir Bridge, Eglington Street, College Road and Eyre Square
- Localised City Centre Traffic Management proposals
- Rationalised Bus Route network with increase services and bus priority
- Improved Cycle Network

These measures in turn will result in an increase in sustainable travel and improvements to pedestrian safety throughout the city centre.

Table 6.32 below presents the mode share between private vehicle, public transport, walking and cycling for the 2012 Base Year, 2024 Opening Year and 2039 Design Year, extracted from the traffic model for the 24-hour period.

The mode share analysis shows that there is a low public transport mode share of just 4% in the Base Year. As can be seen below, the impact of the Do-Something options on mode share is minimal, with Car Mode share increasing by circa 1% in both 2024 and 2039 as a result of the opening of the proposed road development.

The GTS test increases Public Transport mode share to 5.0%, which is a 16% increase in Public Transport trips relative to the Do-Minimum Scenario.

Table 6.32: Mode Share Percentages

Option	% Car	% PT	% Walk	% Cycle
2012 Base Year	66.7%	3.9%	26.3%	3.1%
2024 Do-Minimum	67.4%	4.2%	25.4%	3.0%
2024 Do-Something	68.4%	4.0%	24.9%	2.7%
2039 Do-Minimum	67.4%	4.3%	25.2%	3.1%
2039 Do-Something	68.6%	4.1%	24.5%	2.8%
2039 GTS	67.3%	5.0%	24.9%	2.8%

Due to the fact that the proposed road development forms a constituent element of the wider reaching Galway Transport Strategy, it is appropriate that the forecast flows in the future year network should be reviewed in the context of the full implementation of the GTS. These flows are outlined in **Table 6.33**. Analysis of these figures indicate that the full implementation of the GTS leads to a smaller increase in traffic crossing the River Corrib in 2039, with total bridge crossings of circa 13,000 higher than the Do-Minimum Scenario. As outlined above, this increase is related to changes in trip distribution and the release of overcapacity demand linked to the opening of the proposed road development.

Table 6.33: Galway Transport Strategy AADT 2039 Design Year – Medium Growth

AADT Point	Location	2039 Do-Minimum Medium Growth		2039 GTS Medium Growth	
		AADT	%HGV	AADT	%HGV
1	N6 South of Galway Airport	23,382	8%	35,906	6%
2	R446 Westof Oranmore Business Park	22,588	10%	25,861	9%
3	R446 South of N6 Roundabout	18,807	7%	29,747	6%
4	N6 South of Briarhill	31,459	7%	17,225	6%
5	N6 Near Ballybrit Business Park	25,974	7%	15,158	5%
6	N6 Between N83 and R865	26,749	6%	20,663	3%
7	N6 Between N84 and N83	20,691	5%	8,536	7%
8	N6 East of Quincentenary Bridge	24,315	6%	21,668	5%
9	N6 On Quincentenary Bridge	34,546	7%	34,950	4%
10	R338 at Westside Playing fields	14,061	5%	7,681	1%
11	Western Distributor Road	11,657	2%	3,062	0%
13	R337 Kingston Road, Kingston	11,955	4%	9,888	1%
15	R336 Barna Road. Barna Woods	16,273	2%	4,815	0%
30	Wolfe Tone Bridge	18,074	4%	13,568	4%
31	O’Briens Bridge	9,725	4%	7,155	1%
32	Salmon Weir Bridge	17,910	1%	-	0%
36	R336 West of N6	10,875	3%	13,013	3%
41	N59-North of GCRR Link Road	17,749	2%	17,749	2%

AADT Point	Location	2039 Do-Minimum Medium Growth		2039 GTS Medium Growth	
		AADT	%HGV	AADT	%HGV
42	N84 South of GCRR	14,298	6%	20,171	4%
50	GCRR – Briarhill Junction			35,906	6%
51	GCRR – Parkmore			38,783	5%
52	GCRR – Between N83 and N84			49,104	5%
53	GCRR – New Corrib Crossing			37,986	4%
54	GCRR – N59 Lnk Road			11,862	4%
55	GCRR – Rahoon Link Road			5,300	3%
56	GCRR - Letteragh Link Road			14,584	3%
57	GCRR – Ballymoneen to N59			22,111	3%
58	GCRR – West of Ballymoneen			19,015	3%
60	GCRR – At Truskey West			10,566	3%
61	GCRR – North of Terminus			10,566	3%

6.9 Summary

There will be no traffic negative impacts of major significance as a result of the introduction of the proposed road development. The traffic impact analysis carried out in **Section 6.6** shows that the introduction of the proposed road development results in significant benefits in terms of junction operation, network performance and journey time savings. By providing an alternative route around the city, the proposed road development will result in reduced traffic levels and congestion in the City Centre.

The RFC analysis in the peak travel periods shows that the proposed road development leads to almost a 50% reduction in the number of junctions operating at or close to capacity. Similarly, journey times on key routes around, and into, the city are reduced during peak periods because of the introduction of the proposed road development. For example, the existing N6, following the opening of the proposed road development experiences journey time savings of between 40% - 50% during peak periods.

As a constituent element of the Galway Transport Strategy the proposed road development will tackle the city's congestion issues, the proposed road development will provide a better quality of life for the city's inhabitants and provide a much safer environment in which to live. By reducing the number of cars on the roads within the city centre and improving streetscapes, workers and school children are facilitated to commute using active modes and on the public transport system. As a result, more sustainable travel will be supported and encouraged.

In the absence of the proposed road development, traffic conditions in the city centre will continue to deteriorate resulting in a situation whereby crossing the city becomes increasingly difficult. This restricted movement of people will lead to changes to where people live and work over time, with people choosing to live and work on one side of the city or another as the delay experienced travelling across the city becomes too great. This change in travel behaviour, or suppression of trip making, will constrain the economic development of Galway City and its environs. The proposed road development will provide the required capacity for all modes of transport in Galway to support economic growth into the future. Further economic benefits of the proposed road development are detailed within the Phase 3 Cost Benefit Analysis Report (included in **Appendix A.6.2**) which estimates that the Net Present Value of the proposed road development to the local and national economy will be in the region of €1.04bn - €1.46bn, with a benefit to cost ratio of approximately 4:1, over the 30-year assessment period.

6.10 References

Transport Infrastructure Ireland, Project Appraisal Guidelines;

- Unit 4: Definition of Alternatives
- Unit 5.1: Construction of Transport Models
- Unit 5.2: Data Collection
- Unit 5.3: Travel Demand Projections
- Unit 5.4: Traffic Modelling Report
- Unit 6.11: National Parameter Values Sheet
- Unit 16.1: Estimating AADT on National Roads
- Unit 16.2: Expansion Factors for Short Period Traffic Counts

Galway City Council Development Plan 2011 – 2017

Galway City Council Development Plan 2017 – 2023

Galway County Council Development Plan 2015 – 2021

UK Department for Transport. (2007) *Guidance on Transport Assessment.*

UK Government. (2013) *Transport Analysis Guidance: WebTAG.*

Highways England. (1999) *Design Manual for Roads and Bridges. Traffic Capacity of Urban Roads. TA78/99.*

National Transport Authority. *National Cycle Manual 2011*.

Department of Transport, Tourism and Sport and the Department of Environment, Community and Local Government. *Design Manual for Urban Roads and Streets (DMURS).*

Galway Transport Strategy 2016 – 2036.

POWSCAR. (Place of Work, School or College – Census Anonymised Records) is produced by the Central Statistics Office based on the 2011 Census and contains geo-coded data on the place of work or education for all workers and students in Ireland.

Environmental Protection Agency. (2002 and Draft, September 2015) *Guidelines on the Information to be Contained in Environmental Impact Statements.*

Environmental Protection Agency. (2003 and Draft, September 2015) *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements.*

Environmental Protection Agency. (2017) *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.*

7 Construction Activities

7.1 Introduction

This chapter of the EIAR describes the construction activities associated with the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development. It considers how the proposed road development will be constructed, including construction fencing, site clearance, any necessary investigations, import and disposal of materials, drainage and general construction activities for road infrastructure.

This chapter initially sets out the methodology followed in preparing this chapter (**Section 7.2**), describes the receiving environment (**Section 7.3**) and describes the construction activities associated with the proposed road development (**Section 7.4**). The potential construction impacts of the proposed road development are described (**Section 7.5**) and proposed mitigation (**Section 7.6**) and residual impacts are described (**Section 7.7**). The chapter concludes with a summary (**Section 7.8**) and reference section (**Section 7.9**).

This chapter has utilised the information gathered during the constraints and route selection studies for the proposed road development and other assessments made under the headings of soils and geology, material assets non-agriculture, noise and vibration, air quality and climate, human beings, population and health, hydrogeology, hydrology, archaeology, architectural and cultural heritage, landscape and visual for this EIAR. This chapter should be read in conjunction with **Figures 7.001** to **7.002**; **7.101** to **7.124**; **7.201** to **7.202** and **7.301** to **7.302**.

7.2 Methodology

The preparation of this chapter is based on a desk study, site walkovers, ground investigations and on information gathered during consultations with landowners and homeowners, utility and service providers and the public.

A construction workshop was held on 17 November 2016 in the Project Design Office. The purpose of the workshop was to review and assess how the proposed road development would be constructed for the associated environmental assessments. The workshop was attended by various environmental specialists interacting with the design team. The specialists from various different disciplines included ecology, noise & vibration, air quality & climate, landscape & visual, geotechnical and hydrology. An overview of the design of the proposed road development and the key constraints to be considered during construction was presented by the design team. A collaborative discussion was held between the various disciplines to highlight any additional potential constraints and impacts associated with the construction. Further follow up collaboration continued between the various specialists and the design team following this workshop. This ongoing interactive process informed the assessments included in this chapter and other relevant chapters of this report.

The main guidelines used in preparing this chapter are:

- Environmental Protection Agency (EPA) Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA, 2017)
- Environmental Protection Agency (EPA) Draft Revised Guidelines on Information to be contained in Environmental Impact Statements (EPA, 2015)
- Environmental Protection Agency (EPA) Draft Advice Notes for Preparing Environmental Impact Statements (EPA, 2015)
- Environmental Protection Agency (EPA) Guidelines on the information to be contained in Environmental Impact Statements (EPA, 2002)
- Environmental Protection Agency (EPA) Advice Notes on current practice in the preparation of EISs (EPA 2003)
- Transport Infrastructure Ireland (TII) guidelines on procedures for assessment and treatment of geology, hydrology and hydrogeology for National Road Schemes (TII, 2009)
- TII Environmental Impact Assessment of National Road Schemes – A Practical Guide (TII, 2008)

7.3 Receiving Environment

The receiving environment is represented by rural lands mixed with the urban fringe of Galway City and includes some built-up suburban development such as that along the N59 Moycullen Road and the N83[1] Tuam Road. The area to the west of the N59 Moycullen Road is underlain with granite and to the east of the N59 Moycullen Road with limestone which needs to be taken into consideration in the reuse of materials during construction. The existing road network which could be used as haulage routes is made up of the National, Regional and Local roads. A description of the proposed haul route network is provided below in **Table 7.4** and shown on **Figures 7.001** and **7.002** and **7.101** to **7.123**. Locations of potential blasting for excavations during construction are shown on **Figures 7.201** and **7.202** and areas proposed for material deposition areas are shown on **Figures 7.301** and **7.302**. A full description of the receiving environment is provided in **Chapter 5, Description of the Proposed Road Development**.

7.4 Construction Activities

7.4.1 Overview

This Section outlines the construction phasing (**Section 7.4.2**), enabling works (**Section 7.4.3**), site preparation and clearance works (**Section 7.4.4**), proposed road closures and diversions (**Section 7.4.5**), potential form of contract **(Section 7.4.6)** main construction activities which for the purposes of this report are divided into sections (**Section 7.4.7**), proposed construction methodologies (**Section 7.4.8**), material sources and transportation including, earthworks quantities, proposed haul routes and construction compounds (**Section 7.4.9**), service and utility diversions (**Section 7.4.10**), employment and welfare (**Section 7.4.8**), construction health and

[1] Formerly known as the N17 Tuam Road

safety (**Section 7.4.12**), commissioning and decommissioning of the construction phase of the proposed road development (**Sections 7.4.13** and **14**).

It is estimated that the overall construction period will last for approximately 36 months. A variety of construction activities will occur simultaneously at a number of locations along the route of the proposed road development, but will be in a phased manner. Construction will be undertaken using internationally accepted methods. Construction of the proposed road development will include activities such as excavation, embankment and structural construction, tunnelling, piling, rock breaking and movement of materials within the fenced off working area. This will generate noise, dust and movement of machinery which will potentially impact on the surrounding environment. A series of best practice mitigation measures described in the relevant chapters of this EIAR will be incorporated during the construction phase to ensure that strict limit values set to avoid significant impacts will not be exceeded at sensitive locations.

A strategy for construction has been developed with the aim of minimising potential environmental impacts at each subsequent phase of the project. Major construction activity such as excavation work, requires the use of powerful and often large and heavy equipment. These works take a significant time period to complete and progressive phases of construction entail different activities and require the use of various types of equipment. Overall, however, construction is a temporary activity. Modern machinery and techniques are sophisticated and are designed to be operated to minimise the impact on their surroundings. Any residual impact, which may arise as a result, is for a limited period of time. The works required to construct the proposed road development are essentially similar to other major construction projects in Ireland and across the world.

The general activities and potential impacts associated with the construction of the proposed road development include:

- Site clearance including demolitions and vegetation clearance
- Fencing
- Site access
- Construction compounds
- Site investigations and archaeological testing
- Quarrying and processing of aggregates
- Material requirement and source of material
- Temporary road closures and diversions
- Water management/treatment
- Temporary storage of materials, surplus materials or wastes arising

The above activities are discussed in the following sections which should be read in conjunction with **Chapter 5, Description of Proposed Road Development**. In addition to the above list the following are also discussed:

- Construction form and duration of works

- Construction constraints
- General construction methods
- Construction programme, staging and working hours

Associated construction activities considered in other chapters of this EIAR are as follows:

- Earthworks and management of excavated material (ref. **Chapter 9, Soils and Geology**)
- Site drainage (ref. **Chapter 5, Description of Proposed Road Development, Chapter 10, Hydrogeology** and **Chapter 11, Hydrology**)
- Construction traffic and access (ref. **Chapter 6, Traffic Assessment and Route Cross-Section**)
- Landscaping (ref. **Chapter 12, Landscape and Visual**)
- Diversion of utilities (ref. **Section 7.4.4.3** below and **Chapter 15, Material Assets Non-agriculture**)

7.4.1.1 Construction Environment Management Plan (CEMP)

A Construction Environmental Management Plan (CEMP) for the proposed road development is provided in **Appendix A.7.5** of this EIAR. The CEMP documents the overall environmental management strategy that will be adopted and implemented during the construction phase of the proposed road development. The purpose of the CEMP is to demonstrate how the proposed construction works can be delivered in a logical, sensible and safe sequence with the incorporation of specific environmental control measures relevant to construction works of this nature. The CEMP sets out the mechanism by which environmental protection is to be achieved during the construction phase of the proposed road development. Implementation of the CEMP will ensure disruption and nuisance are kept to a minimum. The following is included in the CEMP:

- General Project Details
- Contact Sheets
- Reference Documents
- Organisational Structure/Duties and Responsibilities
- Environmental Commitments and Environmental Control Measures
- Site Specific Method Statements/Management Plans
  - Construction and Demolition Waste Management Plan
  - Sediment, Erosion and Pollution Control Plan
  - Non-native Invasive Species Management Plan
  - Incident Response Plan
  - Construction Traffic Management Plan
- Environmental Awareness Training Strategy
- Communications Strategy

- Inspections, Auditing and Monitoring Compliance Strategy
- Final Handover

The CEMP as provided in **Appendix A.7.5** must be read in conjunction with the construction details already provided in the EIAR. Refer also to **Section 7.6.1** of this chapter for further details on the CEMP.

7.4.2 Construction Phasing

An east to west build sequence is likely to be adopted and construction may be completed in two concurrent phases or a single overall contract:

- Phase 1 – N6 Coolagh to N59 Letteragh Junction – 9.9km (Including the N59 Link Road North and South.)
- Phase 2 – N59 Letteragh Junction to R336 Coast Road west of Bearna - 7.5km

Completion of Phase 1 would provide the benefit of a new river crossing and also provide a new connection to the N59 Moycullen Road and greater Knocknacarra area. The N59 Link Road North and South and Parkmore Link Road could also potentially be constructed as part of an advance works contract however these will be assessed as part of the main contract for the purpose of this EIAR as the associated environmental impacts would be the same.

Completion of Phase 2 would enable a full connection from the west of Bearna Village and to the east in Coolagh, Briarhill with various at-grade and grade separated connections.

7.4.3 Enabling Works

Enabling works are those generally undertaken to existing facilities in order to provide space or access for the permanent works and or construction. By their nature, these works must be complete before the main works can start. The timing of enabling works depends on the programmed start of the phase of main works that they are designed to enable. Some may start well in advance of the main construction activities. The potential environmental impacts associated with the enabling works have been considered in this EIAR.

Before the start of the main construction works, there will be elements of enabling and preparatory works, such as utility diversions, ground investigation, treatment of non-native invasive species and archaeological investigations, which are designed essentially to clear the ground for the main activities. These activities have been considered at this stage to ensure all necessary land and access is included within the proposed development boundary.

Some examples of main enabling works are as follows:

- Diversion of 110kV ESB overhead lines at Coolagh, Briarhill, and Ballybrit
- Diversion of the Gas distribution network at Rahoon and Gas transmission network at School Road

- Racecourse Avenue diversion and the realignment of the northern access to Galway Racecourse, construction of temporary stables and replacement of two wells for Galway Racecourse

7.4.4 Site Clearance and Preparation Works

Site clearance including demolitions, vegetation clearance and treatment of non-native invasive species will be undertaken within the proposed development boundary. The clearance of vegetation and treatment of non-native invasive species will be done in accordance with the Construction Environmental Management Plan (CEMP) (**Appendix A.7.5**). There are restrictions for site clearance and construction at locations of breeding birds. Where feasible, vegetation (e.g. hedgerows, trees, scrub and grassland) will not be removed, between the 1 March and the 31 August, to avoid direct impacts on nesting birds. Where the construction programme does not allow this seasonal restriction to be observed, then these areas will be inspected by a suitably qualified ecologist for the presence of breeding birds prior to clearance. Areas found not to contain nests will be cleared within 3 days of the nest survey, otherwise repeat surveys will be required, (*ref* ***Chapter 8, Biodiversity***).

All areas of the site required for the construction of the proposed road development will need to be cleared down to ground level, with in some cases demolition of existing structures including residential dwellings and commercial properties, ref **Chapter 15, Material Assets Non Agriculture**. Trees will be protected where practicable when construction accesses are formed. The presence and nature of items of heritage significance will be recorded and preserved where possible. Archaeological monitoring and investigations will also be undertaken in order to record and preserve any buried findings using the appropriate methods.

Access for additional ground investigation work and archaeological testing have been considered as part of this EIAR and are included within the proposed development boundary.

Surplus materials will be reused within the works for the proposed road development where feasible and subject to appropriate testing to ensure it is suitable for its end use. Unavoidable wastes generated will be managed as outlined in **Section 7.6.8 Waste Management**.

7.4.4.1 Fencing

At the beginning of the construction phase the land to be acquired as per the proposed development boundary will be fenced and access across it restricted. Temporary construction fencing or hoarding may be required during construction prior to the installation of permanent fencing to secure the site and prevent unauthorised access. Fencing in accordance with TII Publications will be used.

Fence types will vary across the proposed road development depending on different circumstances which may require, timber post and rail fencing, timber post and mesh fencing, masonry walls, steel palisade fencing, noise barriers, parapets and may be temporary in nature. The method for erecting the fence will also vary depending on the location of sensitive receptors such as the presence of Annex I habitats. For example, the fencing at the Menlough Viaduct will be erected without in any way impacting on the Annex 1 habitat, namely Limestone pavement (ref **Appendix A.7.2**). The contractor will be required to prepare a method statement in order to demonstrate this. In certain situations, temporary crossing points for livestock and machinery will be allowed until accommodation roads are constructed. Fencing will also be erected from the proposed road side of the fence. In areas where the proposed development boundary includes Annex I habitat within Lough Corrib cSAC the permanent fencing will be located between the proposed road and the Annex I habitat and will not be located within the habitat areas.

7.4.4.2 Water Management

Site drainage will be provided to collect surface water runoff, which will be directed into a site water treatment facility before being discharged to the local drainage network. Pre-earthwork drains will need to be constructed in advance of main earthworks to prevent flooding of adjacent lands or vice versa.

Drainage ponds and interceptor ditches will also need to be constructed in advance of main earthworks to collect, treat and discharge all surface water run off during construction. Silt traps will be required for any construction in proximity to sensitive watercourses.

As detailed in the CEMP (**Appendix A.7.5**) (such as the sediment, erosion and pollution control plan) specific controls/mitigation measures will be put in place to manage runoff and minimise pollution to receiving waterbodies during the construction phase. Further details on same are also provided in **Chapter 10, Hydrogeology** and **Chapter 11, Hydrology**.

Construction dewatering will be required and managed at the following locations:

- Interception of groundwater for cuttings in the Galway Granite Aquifer, with groundwater discharged to surface watercourses
- The cutting west of the N83 Tuam Road Ch. 13+050 to Ch. 13+650 (EW27) may encounter groundwater seasonally during peak groundwater levels in the Visean Undifferentiated Limestone. The design includes drainage to intercept and carry groundwater away from the construction for discharge in the same groundwater body
- The Galway Racecourse Tunnel and its approaches will include dewatering of the Visean Undifferentiated Limestone. The construction drainage will intercept and carry groundwater away from the construction for discharge in the same groundwater body

Further details on same are also provided in **Chapter 10, Hydrogeology**.

7.4.4.3 Utilities Diversion

All utility diversion work such as electrical, telecommunications, gas and water are assessed in **Chapter 15, Material Assets Non Agriculture**. The key main diversions include four 110kV overhead line diversions at Ballybrit and Coolagh, one gas main diversion at Rahoon, one temporary gas main and foul sewer diversion at School Road Castlegar, and two foul main sewer diversion at Ballybrit and Ballymoneen Road.

7.4.4.4 Demolitions

Demolition of existing buildings is required at a number of areas and these demolitions are considered and assessed in **Section 14.5.3** of **Chapter 14, Material Assets Agriculture** and **Section 15.5.2.1** of **Chapter 15, Material Assets Non-agriculture** and shown on **Figures 14.1.1** to **14.1.15**.

The demolition work will be carried out by a specialist demolition contractor who will operate in accordance with the method statement and Health and Safety legalisation (refer to **Section 7.4.12** below). The method statement will outline how the contractor proposes to undertake the demolition works in accordance with the CEMP in order to demonstrate that the work will be carried out safely and to ensure that significant environmental impacts will not arise. This method statement will be approved by the Employer in advance of any works.

As detailed in the CEMP (**Appendix A.7.5**), the Contractor will put in place a Public Communications Strategy which will provide a two-way mechanism for members of the public to communicate with a designated member of the Contractor's staff and for the Contractor to communicate important information on various aspects of the proposed road development to the public. This will include a communications strategy for notifying neighbouring residences of proposed demolitions in the area. Warning signs will be erected notifying people of dangers of moving plant/demolition works.

In addition, a suite of mitigation measures and specific controls that the contractor is obliged to put in place in relation to construction works (including demolition works) is specifically detailed and set out in the CEMP in **Appendix A.7.5** and **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration** (refer to **Section 7.4.1** and **Section 7.6** for further details).

Prior to the commencement of any demolition works, security fencing will be erected around the area to be demolished and regularly checked to see that it is in a satisfactory condition. Potential impacts to neighbouring properties during construction will be mitigated by the implementation of the measures outlined in **Section 7.6** below.

Prior to any demolition, asbestos surveys will be carried out on all structures to determine if there are any asbestos materials present. Demolition work will not take place unless the structure has been safely cleared of asbestos. Properties will be surveyed for asbestos containing materials by a competent person and the asbestos materials will be removed by trained personnel and placed into appropriate packaging ready for removal off site in accordance with Health and Safety legalisation (refer to **Section 7.4.12** below) thereby ensuring significant environmental impacts will not arise.

Prior to the heavy demolition works taking place, all rubbish and debris surrounding the property will be removed and placed into skips for recycling/disposal. These materials will include all the domestic waste, furniture and kitchen appliances dumped on, in or around the properties. These materials will be removed using mechanical techniques and segregated and stockpiled for removal off-site.

Before the commencement of demolition works, all existing services will be identified, located and turned off. This includes ESB, water, gas and telecommunications. The contractor will ensure all services to properties are off before demolition works commence.

A bat survey is to be completed at all properties prior to being demolished. This will involve the ecologist using a cherry picker to access the roof tiles and removing several tiles. Once the ecologist confirms the roof space is clear the demolition can take place.

The demolition process will include the mechanical demolition of buildings and the removal of the materials from site. The works will be carried out as swiftly as possible and in an efficient and safe manner. Demolition works will be carried out under strict supervision at all times. Demolition of buildings will be well supervised with the area around the building closed off to unauthorised personnel.

Demolition of the larger structures will commence from the roof structure working downwards. The contractor will use a large tracked excavator for the demolition works which will provide extra reach and extra power for the task at hand. A water bowser will be used to suppress dust from the demolition works should the need arise. Dust suppression units will be provided to disc cutting machines, to dampen down dust.

The properties affected will be demolished and all rubble stockpiled for removal. Demolition shall be completed in a controlled manner with no operatives allowed near the structure until the building is completely levelled. All material will be removed off site to a licenced facility. No buildings will to be left in an unstable or unsafe condition.

In general, excavators or other suitable equipment will be utilised to peel off the front walls of the properties first to enable access to remove the floors and their contents. The materials will be pulled clear of the structure to a suitable area for further processing, segregation and loading. The remaining concrete structures will then be demolished and temporarily stockpiled where they fall. The excavator may crunch the structure on a bay by bay basis into small sections which will allow the structure to be progressively demolished in a safe manner. This will minimise the dropping of large sections of concrete to the ground in an uncontrolled manner.

When demolition operations allow materials such as timber, steel and concrete will be gathered to a central location, where it will be sorted and segregated for removal off site. On completion of the removal of the property internal structures, the remaining external walls will be pulled down and stockpiled. Removal of waste materials will be carried out during all stages of the mechanical works to create a safe and workable site for both the excavator and the operatives on site. When enough material has been accumulated the segregated stockpiles will be removed for disposal and or recycling.

Temporary disruption to services in the locality may arise during the course of the work but these will be re-instated. In liaison with the local service providers, all services will be disconnected prior to demolition works.

A designated point man will be present to allow safe manoeuvring of machinery/hauliers. Construction traffic will be managed safely and in accordance with the overall construction traffic management plan (**Appendix A.7.5**).

No operatives will work under areas of demolition and all equipment operated by the employees will be maintained in good working order and inspected in accordance with manufacturers recommended intervals. All work will be carried out in accordance with the method statement and under fulltime supervision.

Construction waste will vary significantly from site to site but typically would include the following non-hazardous fractions:

- Soil and stone
- Concrete, brick, tiles and ceramics
- Asphalt
- Metals
- Wood
- Other

The hazardous waste streams which could arise from construction activities may include the following:

- Waste electrical and electronic components
- Batteries
- Asbestos
- Wood preservatives
- Liquid fuels
- Contaminated soil

Any metals that can be salvaged for recycling will be removed and stored separately. All glass in the property such as windows and doors, will have been removed prior to demolition works to remove the dangers associated with broken glass in the rubble or during demolition works.

In all cases where demolition and site clearance is being undertaken, the relevant archaeological and architectural heritage mitigation measures will be implemented. Refer to Section 7 Construction & Demolition Waste Management Plan of the CEMP included in **Appendix A.7.5**.

All potential impacts associated with the demolition works are fully assessed within the relevant chapters of this EIAR.

7.4.4.5 Site Offices and Compounds

Site preparation works will also include the facilities for the contractor and the construction management team.

These will include the following:

- Setting up of access control to the site
- Site offices
- Site facilities (canteen, toilets, drying rooms, etc.)
- Offices for construction management team
- Secure compound for the storage of all on-site machinery and materials
- Temporary car parking facilities
- Permanent and temporary fencing
- Site security

See **Section 7.4.9.4** for more information on site compounds.

7.4.4.6 Concrete Batching and Rock Crushing Plants

Locations for concrete batching and rock crushing plants within the proposed development boundary have been considered as part of this EIAR. It is proposed to include a concrete batching and rock crushing plant at Lackagh Quarry (Site Compound SC 11/01). Lackagh Quarry site compound will be one of the principal site compounds across the proposed road development, given its size and location in relation to the overall proposed road development. It is also proposed to include a rock crushing and grading plant at site compounds in close proximity to the major cuttings across the proposed road development in order to minimise the distance for haulage of excavated material. It may also be necessary to utilise a mobile rock crushing unit to minimise haulage of excavated material. See **Table 7.5** below for a summary of potential site compounds and possible locations identified for concrete batching and rock crushing plants. The appropriate authorisation for crushing plants such as waste facility permits will be obtained by the operator prior to commencement of the activity.

7.4.5 Road Closures and Diversions

The proposed road development will be constructed in a manner which will minimise, as much as possible, any disturbance to the local residents and road users. Requirements for temporary traffic management during the construction of the proposed road development will be explicitly written into the Employer's Requirements for the construction contract documents and tenderers will have to demonstrate compliance with these requirements during the tender process.

There are two locations where temporary road diversions will be in place in order to construct bridge structures at Ch. 3+300 Aille Road L5384 and Ch. 13+150 School Road, Castlegar L2134. A plan outline of these proposed temporary diversions is presented in **Figures 7.001** and **7.002** and described below in **Section 7.4.5**.

Temporary night-time closure of existing roads may be required where overbridges are to be constructed at locations such as the Rahoon Road, Letteragh Road, N59 Moycullen Road, Menlo Castle Bóithrín, Bóthar Nua, An Seanbóthar, N84 Headford Road, N83 Tuam Road, Briarhill Business Park Road and R339 Monivea Road.

As detailed in the CEMP (**Appendix A.7.5**), the Contractor will put in place a Public Communications Strategy which will include procedures to inform members of the community who may be directly affected by the construction phase on schedules for any activity of a particularly disruptive nature which is likely to impinge on their property such as blasting, demolition, road closures and diversions, pile driving and any mitigating actions that are being taken (shielding, restriction on work hours, etc.) to minimise such disruption.

There are two permanent road closures proposed along the proposed road development. The Ann Gibbons Road (L13215) at Ch. 2+500 in Troscaigh will be severed by the proposed road development and a permanent diversion for local traffic will be required via the existing Bearna to Moycullen Road L1321. The existing link road from the Western Distributor Road Roundabout at Gort na Bró to the Knocknacarra Shopping Centre will be closed and replaced with a new link road connecting to the Gort na Bró Road. Details of these road closures are shown on **Figures 7.102** and **7.113**.

In order to minimise the impact on local residents, landowners and the public, access to existing residential areas, business premises and public facilities will be maintained during construction.

7.4.6 Potential Form of Contract

Whilst a decision on the exact contractual arrangements for the construction of the proposed road development has not yet been made, the proposed road development is suitable for development as a Design and Build (D&B) Scheme or a Public Private Partnership (PPP) contract.

Regardless of the form of contract, the Contractor for the works will be contractually bound within the contract by any conditions arising from the site constraints, the commitments and mitigation measures set out in the EIAR, the employers requirements for the project, any modifications that may be imposed on the proposed road development by An Bord Pleanála and any conditions imposed by An Bord Pleanála and or other Statutory Regulations. This may incorporate alternative details provided it can be demonstrated that it provides the same performance criteria (or higher) than those outlined in the CEMP. Prior to construction the CEMP will be finalised by the Contractor and approved by the Employer. The CEMP is included in **Appendix A.7.5** and summarises the overall environmental management strategy that will be adopted and implemented during the construction phases of the proposed road development. The purpose of the CEMP is to demonstrate how the proposed construction works can be delivered in a logical, sensible and safe sequence with the incorporation of specific environmental control measures relevant to construction works of this nature.

7.4.7 Main Construction Works

The main construction works will involve the excavation and placement of material for the construction of cuttings and embankments as well as the hauling of materials and importation/exportation of materials to complete the road formation. Materials for the road construction will include materials that need to be brought to site including gravels and bituminous pavement and surfacing materials. In addition to the earthworks construction the main activities will involve the following:

- Road Works — sub-base and base construction, bituminous pavement, surfacing
- Drainage — the installation of pipe culverts, filter drains, linear grassed channels and wetlands
- Structures — the construction of retaining walls, piling works, construction of bridges and viaducts including their foundations, piers, abutments and the installation of large beams and other reinforced concrete works
- Tunnels – the construction of a mined tunnel and a cut and cover tunnel
- Blasting – excavation of rock for cuttings and tunnels. (See also **Chapter 9, Soils and Geology**)
- The diversion and construction of utilities and services
- Ancillary roadworks including the installation of safety barriers, signage and road marking
- Accommodation works for landowners such as access roads, entrances, fences, gates, walls, ducting and reconnection of severed services
- Temporary traffic management

The main construction work for the proposed road development will be split up into different sections along the route of the proposed road development. The proposed phasing of construction is discussed above in **Section 7.4.2**.

Table 7.1 below provides a summary of these sub divided construction sections (going from west to east) and includes the estimated duration of construction for each section. Sections may be completed simultaneously and combined in certain areas. Some sections will be constrained to certain times of the year and some require enabling works. A likely sequence of construction is presented as part of this EIAR, this is based on a worst-case scenario so that all potential impacts are considered. It is likely that the contractor will construct the proposed road development in a sequence which gives rise to lesser impacts than those described. All construction will be employed using best practice methods and in accordance with the relevant standards.

Table 7.1: Construction Sections

Section No.	Phase	Location	Chainage (m)		Length (m)	Time Constraint	Estimated Construction Time (months)
			From	To			
S1	2	R336 to Aille	0+000	3+300	3300	No	6-9
S2	2	Aille to Ballymoneen Road	3+300	5+650	2350	No	6-9
S3	2	Ballymoneen Road to N59 Letteragh Junction	5+650	7+550	1900	No	9-12
S4	1	N59 Link Road South (LRS)	LRS 1+050	2+020	970	No	9-12
S5	1	N59 Link Road North (LRN)	LRN 0+000	0+950	950	No	9-12
S6	1	Letteragh Junction to River Corrib	7+550	8+850	1300	No	6-9
S7	1	River Corrib Bridge	8+850	9+500	650	No	18-24
S8	1	River Corrib Bridge to Menlough Viaduct	9+500	10+100	600	No	9-12
S9	1	Menlough Viaduct	10+100	10+430	330	No	18 - 24
S10	1	Menlough Viaduct to Lackagh Tunnel	10+430	11+150	720	Yes – Construction to be completed without any groundwater dewatering. Construction may cease when groundwater levels are too high to allow dry working. However, works above this level may continue.	24-36

Section No.	Phase	Location	Chainage (m)		Length (m)	Time Constraint	Estimated Construction Time (months)
			From	To			
S11	1	Lackagh Tunnel	11+150	11+400	250	Yes – To be constructed without groundwater dewatering and as such works may need to cease during the winter groundwater high. However, works above this level may continue. Start before mid-February (Peregrine Breeding Season)	24-36
S12	1	Lackagh Tunnel to School Road	11+450	13+150	1700	No	12-18
S13	1	School Road to Galway Racecourse Tunnel	13+150	14+950	1800	No	12-18
S14	1	Galway Racecourse Tunnel	14+300	15+150	240	Yes. Construction sequence plan in accordance with Galway Racecourse Festivals and Activities	24-36
S15	1	Galway Racecourse Tunnel to Coolagh Junction	15+150	17+450	2300	No	12-18

An overview of each section and its associated construction activities are discussed in the following sections which should be read in conjunction with **Chapter 5, Description of Proposed Road Development** which includes a full description of the proposed road development and **Figures 7.001** to **7.002** and **7.101** to **7.123** which show the locations of the proposed sections, site compounds and haul routes. **Figures 7.201** and **7.201** show potential locations of blasting for excavation during construction.

7.4.7.1 Section S1 – R336 Baile Nua to Aille

This section consists of 3,300m of single carriageway and includes two roundabouts, 11 accommodation roads and eight structures. The main structures along this section include an overbridge at Na Foraí Maola at Ch. 1+375 and an overbridge at Aille Road L5384 Ch. 3+300 and seven culvert crossings. There are six proposed drainage networks located on this section each consisting of an oil and petrol interceptor, a constructed wetland and an attenuation pond.

The proposed level of the proposed road development in this section is largely at-grade or in slight fill to maintain connectivity to the local network via an overbridge and roundabouts. The Aille Road L5384 will be raised by c. 4m as the mainline will cross under the local road and will be in a cutting. The main access to this site will be from the R336 at Baile Nua and L-1321 Bearna to Moycullen Road. A site compound (SC 00/01) is proposed on the west of this section at the R336 Baile Nua.

The Aille Road L5384 will be temporarily realigned to the east to accommodate the construction of the overbridge. Traffic disruption will be kept to a minimum during construction of this section. For the construction of the roundabout at the R336 in Baile Nua and the Bearna to Moycullen Road Roundabout traffic will be diverted through one half of the roundabout once complete until the other half is constructed. Similarly, access will be maintained north and south of the proposed road development during the construction of the Foraí Maola to Troscaigh overbridge and associated link roads. Temporary traffic management may be required at certain times to maintain safe access.

The Ann Gibbons Road (L-13215) will be severed by the proposed road development therefore access will be diverted via the L-1321 Bearna to Moycullen Road. It is also proposed to overlay a portion of the Ann Gibbons Road due to its current poor condition.

7.4.7.2 Section S2 – Aille to Ballymoneen Road

This section consists of 2,350m of single carriageway and includes two at-grade signalised junctions, and ten accommodation roads. The mainline of the proposed road development is largely in cut on the western end of this section as it crosses under the Aille Road L5384 and rises back to at-grade at approximately Ch. 3+900. Substantial material excavation will be required here to remove the overburden and underlying granite rock. **Section 7.4.9** below gives a summary of earthworks quantities. Groundwater seepages from the cutting are expected to be low and will be accommodated in interceptor drains. Excavation for this cutting will likely require blasting and material excavated will be tested for suitability for use along the fill sections west of the River Corrib, (ref. **Chapter, 9 Soils and Geology**).

There are four drainage networks proposed and five culverts. Site compounds (SC 04/01 & SC 05/01) are proposed at Ch. 4+000 and Ch. 5+250 west of Ballymoneen Road. Access to the site will be from the L-1321 Bearna to Moycullen Road and Cappagh Road.

Similarly, to Section S1, minimal traffic disruption is expected to local traffic with the construction of the Cappagh Road and Ballymoneen Road signalised junctions. Temporary traffic management may be required during diversion phases.

7.4.7.3 Section S3 – Ballymoneen Road to Letteragh Junction

This section consists of 1,900m of dual carriageway, two slip lanes for the N59 Letteragh Junction and five accommodation roads. A substantial volume of engineering fill is required here which will potentially be sourced locally from a proposed cutting at Letteragh (if the material extracted is acceptable after crushing and grading), otherwise it will be imported to site from a certified source. **Section 7.4.9** below gives a summary of earthworks quantities.

The main structures consist of three underbridges and four culverts. There are three drainage networks located in this section. The nearest site compound (SC 07/01) is proposed at Ch. 7+550. To minimise traffic disruption temporary night time closures of Rahoon and Letteragh Roads may be required during the construction of the underbridges which will require lifting of beams from either side once supporting structures and embankments have been constructed. The Clybaun Road Junction at Mincloon will be realigned in advance of the underbridge construction to redirect traffic safely. Temporary traffic management may be required also during this phase. Access for haul route traffic across Rahoon and Letteragh Road will be manned by stop/go personnel.

7.4.7.4 Section S4 – Letteragh Junction to Rahoon Road (N59 Link Road South & Gort na Bró Upgrade)

This section consists of 930m of the N59 Link Road South which consists of 7m wide single carriageway with 2m footpaths in both directions. Due to undulating landscape in the area the lengths of cut and fill vary. The section going from north to south is largely in cut for c.300m and rises to an at-grade signalised junction at Letteragh Road, then continues on embankment for c.200m and lowers to at-grade again to join with the Rahoon Road.

There are two proposed drainage networks to be constructed in this section and one combined hydraulic culvert and mammal underpass. Groundwater seepages from the cutting are expected to be low and will be accommodated in interceptor drains. There are six access roads to be constructed in this section including a realigned entrance to the Rosán Glas housing estate. Temporary traffic management may also be required during the road closure and diversion stage. There is also a diversion of a gas distribution network at the Rahoon Junction. The nearest site compound is located in Letteragh (SC07/01). There will be minimal interference with local traffic as the majority of this section is offline. Access across Letteragh and Rahoon Road will be manned by stop/go personnel to ensure safety of access/egress. Letteragh and Rahoon Road will require upgrade work including widening at the proposed signal crossings for turn lanes, realignment of vertical curvature to improve visibility and a pavement overlay of the existing network as shown in **Figures 5.001** to **5.015**.

The Gort na Bró Roundabout on the Western Distributor Road is to be converted to a signal controlled junction. A new link road and entrance to the Gateway Retail Park in Knocknacarra is to be constructed to replace the fifth arm off the existing roundabout. The Western Distributor road will widen to allow for two-way bus lanes on approach to the junction and provide for future connectivity of the public transport network. Temporary traffic diversions may be required during this construction phase. The contractor will ensure to minimise any traffic disruption during this phase.

7.4.7.5 Section S5 – N59 Letteragh Junction to N59 Moycullen Road (N59 Link Road North)

This section consists of 1,050m of 7m wide single carriageway with 2.0m footpaths in both directions. This link road connects the Letteragh Junction to the existing N59 Moycullen Road at Bushypark. A deep excavation (9-12m for c.300m) is required to connect this link road at-grade to the N59 Moycullen Road, therefore a substantial volume of soil and rock excavation will be required. Noise and vibration levels will be monitored carefully during excavation due to the proximity of residential properties (ref. **Chapter 17, Noise and Vibration**).

All material excavated will be tested for suitability for use in fill sections to the west of Letteragh. Site compound (SC 07/01) located nearby will be used for temporary stockpiling of excavated material. The N59 Moycullen Road will require some upgrade work to widen at the location of the proposed signalised junction. Temporary traffic management may be required during this phase.

One drainage network is to be constructed north of the N59 Moycullen Road to treat surface water runoff from this section before discharging to the River Corrib. This network consists of a hydrocarbon interceptor, constructed wetland and attenuation pond connected via an underground pipe. Groundwater seepages from the cutting are expected to be low and will be accommodated in interceptor drains.

7.4.7.6 Section S6 – N59 Letteragh Junction to River Corrib

This section includes 1,300m of dual carriageway and two slip lanes for the N59 Letteragh Junction and consists of one of the largest cuttings in the proposed road development (>14m) for the N59 Letteragh Junction which will likely require drill and blasting excavation, refer to **Chapter 9, Soils and Geology** of this EIAR for the quantities and types of soil and rock excavation at this location. Groundwater seepages from the cutting are expected to be low and will be accommodated in interceptor drains. A large site compound SC 07/01 (2.93ha) is proposed in close proximity to this cutting to allow for crushing, regrading and temporary stockpiling of excavated material and storage of plant machinery. This site can be accessed from the east via N59 Moycullen Road or from the north once the N59 Link Road is constructed.

There is one underbridge proposed in this section, spanning over the N59 Moycullen Road. Night time closures of the N59 Moycullen Road may be required to construct the bridge and temporary traffic management will be in place for diversions.

Also included in this section are five accommodation roads, one culvert, four retaining walls, and four mammal underpasses. Material for the fill sections will be sourced locally from the excavated section of the N59 Letteragh Junction where possible. Site compound (SC 08/01) is the located at Ch. 8+700 and access will be from the N59 Moycullen Road. This will be a storage only compound.

There are three drainage networks which discharge directly to the Lough Corrib cSAC, namely S15, which drains the proposed N59 Link Road North and outfalls to an existing drainage ditch which ultimately outfalls to the River Corrib, S18A and S18B which both directly discharge to the River Corrib as shown on **Figures 11.6.106** and **11.6.107**.

Additionally, there are two drainage networks (S14A and S14B) which outfall indirectly to the Lough Corrib cSAC via an existing stream which flows to the west of Aughnacurra residential estate as shown on **Figures 11.6.106**.

A working width of 15m is available for the construction of the above drainage networks to allow room for the necessary machinery and equipment to operate. The extent of the proposed development boundary does not include any Annex I habitat within the Lough Corrib cSAC in these areas.

The headwall at the outfalls in to the Lough Corrib cSAC will be constructed flush with the existing drainage bank. The headwall can be constructed using either a precast headwall or by casting the headwall in-situ. For either method, the construction process will be undertaken using standard best practices. Where the headwall will be constructed using a precast headwall, a temporary cofferdam structure can be constructed if necessary to allow the precast concrete headwall to be lowered into position. Where the headwall is to be cast in-situ, a temporary cofferdam will be constructed to allow the necessary ground works to be completed and to cast the headwall. This cofferdam is used to prevent any potential impact to the water quality of the river/stream/drainage ditch. Where any pumping of water is required, this water will go through environmental treatment to remove all pollutants before being reintroduced to the local surface water drainage network. Once the headwall has been constructed the temporary cofferdam is removed.

7.4.7.7 Section S7 – River Corrib Bridge

The River Corrib Bridge clear spans the river (i.e. with no piers in the river) and as such a balanced cantilever construction is proposed over the river section and the spans over the river banks. Due to the larger span, the superstructure structural depth is significantly larger at the pier locations and varies in depth along the span. This increases the construction complexity of the deck. Post-tensioned in-situ concrete deck can be built using travelling formwork over the river and side spans; and using falsework or travelling formwork on approach spans. For full details of the proposed construction of the River Corrib Bridge see **Appendix A.7.1**.

The bridge continues on a viaduct west of the River Corrib to maintain access for the NUIG Sporting Campus, therefore, management of construction traffic and material delivery is required to minimise disruption and interaction with activities in the sports campus at peak times.

There are two drainage networks proposed west and east of the River Corrib in Section S7. There are two site compounds located in close proximity to the structure on the west (SC-08/01 (storage compound only)) and east (SC-09/01) of the River Corrib.

7.4.7.8 Section S8 – River Corrib Bridge to Menlough Viaduct

This section consists of 600m of dual carriageway and is mainly on embankment. There is one underbridge structure over Menlo Castle Bóithrín, a mammal underpass and a retaining wall to be constructed along this section. Three accommodation roads will be constructed, and three mammal underpasses/culverts. It is proposed to realign An Bóthar Nua to accommodate the underbridge and improve overall safety of this road. Temporary traffic management may be required during this work.

A retaining structure, reinforced soil embankment, between Ch. 9+850 to Ch. 10+050 will retain the proposed road development from encroachment on the Annex I habitat of the Lough Corrib cSAC. The construction of the retaining structure will be undertaken within the proposed development boundary and outside the areas of Annex I habitat. The reinforced soil embankment will be constructed using heavy plant machinery with the height of the retaining structure increasing at the same rate as the embankment height increases.

A site compound (SC-09/01) is proposed east of the River Corrib off the Menlo Castle Bóithrín and access to this site will be from Bóthar Nua in Coolough once site clearance and haul routes have been completed. There is an infiltration basin located east of the River Corrib and south of the proposed road development. Material for the fill sections will be sourced from nearby cuttings where feasible such as the western approach for Lackagh Tunnel, otherwise it will be imported to site from a certified source. Material can be transported from stockpiles, once crushed and re-graded, along haul routes identified in **Figure 7.107**.

7.4.7.9 Section S9 – Menlough Viaduct

The Menlough Viaduct is required to span over Annex I habitat, namely Limestone Pavement and a Turlough adjacent to the Lough Corrib cSAC. There are three alternative construction methods possible for constructing Menlough Viaduct to reduce the potential impacts to the Annex I habitats. Construction Method 1 includes the construction of a protection system over the Limestone pavement and using this as a construction platform and Construction Method 2 utilises the balanced cantilever system in conjunction with a protection system over the Limestone pavement. Construction Method 3 is a prestressed precast beam superstructure construction method. This method is similar to Method 1 and a protection system the Limestone pavement will be provided.

The stages of the construction under the proposed methodologies are as follows:

- Stage 1 - Site access and enabling works
- Stage 2 - Construction of the Limestone pavement protection system
- Stage 3 - Viaduct construction

All of the construction methodologies are described in full in **Appendix A.7.2** and incorporate the need to protect the Annex I habitats. There is some scope to integrate the methodologies to incorporate aspects of the cantilever method and to add false work if required.

The potential environmental impacts of each of these three construction methodologies are the same and have been fully assessed in this EIAR. All such construction methodologies ensure that there will be no effect on Annex I habitats with the exception of the removal of Limestone pavement for one of the pier locations.

A specialised sealed drainage system will capture the runoff on the bridge deck, transport it beneath the structure in a network of sealed carrier drains, before discharging to a wetland and infiltration basin at a suitable location located east of the viaduct. This specialised sealed drainage system is required due to the sensitivity of the areas which the viaduct is crossing above i.e. Annex I habitat.

7.4.7.10 Section S10 – Menlough Viaduct to Lackagh Tunnel

This section consists of 720m of dual carriageway commencing on embankment after the Menlough Viaduct before entering a deep cutting of 7-12m for a length of c.300m as it approaches Lackagh Tunnel. There are three accommodation roads to be constructed to maintain farm land access as well as to facilitate an emergency exit road. Seanbóthar will require upgrading, overlay and verge widening at the underbridge.

Two drainage networks are proposed in this section which consists of an oil and petrol interceptor, a constructed wetland and infiltration basin. A culvert structure is proposed at Ch. 10+735 for a stream diversion. Retaining walls on the approach to Lackagh Tunnel will be constructed to retain the embankment of the proposed road development from encroachment on the Annex I habitat of the Lough Corrib cSAC. The construction of the retaining wall will be undertaken within the proposed development boundary and outside the areas of Annex I habitat. The construction process for the retaining wall will be undertaken in tandem with the construction of the embankment. The embankment will be constructed using heavy plant machinery with the height of the retaining wall increasing at the same rate as the embankment height increases.

A combination of retaining systems will be implemented along the Western Approach and above the western tunnel portal at Lackagh Tunnel (Ch. 10+850 to Ch. 11+150) where the use of unsupported slopes is not used as they would encroach on areas of Annex I habitats. The retaining system type is governed by the ground conditions encountered at that particular location. Within this area the rock head level changes significantly, requiring retaining system solutions for shallow and deep rock ground conditions which can be constructed outside the Annex I habitat within the Lough Corrib cSAC.

The retaining systems constructed in this area include the following construction methodologies:

- In areas of shallow rock:

    The overburden will be removed followed by rock excavation which will be progressed in levels in a cyclic manner including drilling, blasting, rock mapping by a geotechnical expert and mucking out. A composite rock stability support system in the form of rock bolts, rock dowels, steel mesh and sprayed concrete will be implemented where required for stability on the rock face prior to excavation to the next excavation level based on the rock mapping results. A watertight reinforced concrete retaining structure will be constructed within the rock excavation cutting, generally at the base of the excavation (where the excavation is below +17.7mOD).

    Prior to undertaking this excavation, a detailed ground investigation, including down the hole geophysical survey to determine the rock mass geometry will be completed to inform the detailed design and ensure that this method is feasible. In the event that this method is not feasible a piled solution from surface level will be implemented, which is described below.

    A trial blast, as per the Schedule of Commitments and will be carried out as part of a blast assessment. The monitored trial blast will be undertaken in the same bedrock formation by the blasting contractor in a controlled location, not exceeding the vibration limitations of the local sensitive receptors, posing no risk to sensitive receptors including Annex I habitat in Lough Corrib cSAC. The trial blast will calibrate the blast design to a site specific design.

- In areas of deep rock (overburden only) or a combination of overburden and rock:

    Piled retaining walls, with ground anchors will be implemented in these areas. The piled wall will be either a contiguous or secant piled wall. Both of these wall types are installed using the same rig and construction methods. A contiguous piled wall is not watertight as it is a linear series of individual piles whilst a secant piled wall can be designed to be watertight as it is a linear series of interconnected/overlapping piles. A watertight system is only required below +17.7mOD, therefore contiguous piled walls will be implemented with a watertight structure constructed within the excavation.

    The piles will be installed from the existing ground level prior to excavation works or from a reduced excavation level where potential impacts to the Annex I habitat in Lough Corrib cSAC can be avoided. The piling rig will be set up outside of the footprint of the Annex I habitat. Once the piles have been installed, the excavation of the overburden and bedrock will be completed. The bedrock will be broken using a hydraulic hammer or by blasting with the piled wall acting as an additional buffer to the rock blast.

    A watertight reinforced concrete retaining structure will be constructed within the excavation footprint where required.

Prior to undertaking the piling works, a detailed ground investigation, will be completed to inform the detailed design and ensure it is site specific.

These retaining solutions are considered and assessed throughout the assessment for this EIAR.

Access to Section S10 will be primarily from Seanbóthar in Menlough. Acceptable material excavated for the Lackagh Tunnel approach will be used for the embankment section. Excess excavated material can be hauled back to Lackagh Quarry site compound (SC 11/01) for temporary stockpiling after crushing and re-grading and used elsewhere on the proposed road development.

7.4.7.11 Section S11 – Lackagh Tunnel

The construction activities for Lackagh Tunnel is split into three sections:

Section 1:	Stabilisation of the Lackagh Quarry Face
Section 2:	Construction of the eastern entry portal
	Construction of tunnel (from east to west) – Mined (drill and blast)
	Stabilisation of the connection to Section 3 (Western Approach)
Section 3:	Installation of retaining wall structures where required
	Excavation of overburden
	Installation of retaining wall temporary/permanent support
	Construction of western approach road

The following construction sequence is envisaged. It is possible for Section 3 to be constructed in parallel with the construction of Sections 1 and 2.

Stage 1:

- Site enabling and preparation works

Stage 2:

- Stabilisation of the Lackagh Quarry western face (Section 1)
- Construction of the tunnel entry portal (Sections 1 and 2)
- Installation of a retaining wall from existing ground level in Section 3

Stage 3:

- Construction of the proposed tunnel (Section 2)
- Ongoing installation of retaining wall from existing ground level in Section 3 and commencement of the excavation works (Section 3)

Stage 4:

- Excavation ongoing for Section 3

- Stabilisation of the rock along the Section 2/Section 3 boundary (if/where required)
- Completion of the proposed tunnel (Section 2)
- Construction of the proposed road (Section 3)

A detailed report of the constructability of Lackagh Tunnel and the Western Approach and its potential impacts are assessed and included in **Appendix A.7.3**. This report concludes that due to the sensitivity of nearby groundwater receptors that construction will be undertaken without dewatering. Peak groundwater levels may lead to construction ceasing during part of the winter. When the groundwater rise occurs all construction activities within the zone below the high water groundwater level for the tunnel will cease and the operation made safe until groundwater levels drop, which may include the installation of berms to prevent groundwater entering or exiting the tunnel from the tunnel portal. Construction shall start before the Peregrine breeding season (before mid-February) rather than after nesting takes place.

Access to the eastern side of this section of the proposed road development will be from Lackagh Quarry which is accessed via Coolough Road and access to the western side will be from Seanbóthar. Lackagh Quarry (SC 11/01) will be the main site compound for this section. It is proposed to construct a tunnel services, monitoring and maintenance building within Lackagh Quarry which will serve the function of maintenance facility for the proposed tunnel. An emergency exit road for westbound traffic will be constructed to allow egress from the proposed road development in advance of the eastern tunnel portal if required. This will exit onto Coolough Road at the existing entrance to Lackagh Quarry. Similarly, an emergency exit road for eastbound traffic will be constructed to allow egress from the proposed road development in advance of the western tunnel portal. This emergency exit road forms part of a loop which exits onto Seanbóthar and then crosses under the mainline and connects back to Bóthar Nua in Coolough. These emergency exit roads will primarily serve as access for emergency service vehicles with gated barrier controlled entry and exit. These will also be used in the event of an over-height vehicle detection to safely remove the vehicle in advance of the tunnel.

7.4.7.12 Section S12 - N84 Headford Road Junction/Lackagh Quarry to School Road

This section consists of 1,700m of dual carriageway with one grade separated junction at the N84 Headford Road. The mainline of the proposed road development will span the N84 Headford Road, therefore temporary night time road closures may be required when constructing the overbridge once supporting structures and embankments have been built up on either side. A temporary diversion of School Road, Castlegar will also be required. The road will be realigned west of the existing road and this will also require a temporary diversion of a gas transmission network and foul sewer which currently runs along School Road. Once the cutting has been excavated from the east and the overbridge structure put in place the gas main and foul sewer can be relocated to the bridge structure.

Site access will be from the N84 Headford Road. The nearest site compound on the west of this section will be Lackagh Quarry (SC 11/01) and on the east will be at Twomileditch (SC 14/01) within the area of the proposed N83 Junction. There will be a large cutting into the eastern face of Lackagh Quarry. Material excavated will be stored at Lackagh Quarry site compound and tested for suitability for use in fill sections of the proposed road development.

The main structures in this section include one underbridge, two overbridges, four mammal underpasses and three retaining walls. There are six accommodation roads to be constructed and three drainage networks included in this section.

The material excavated from the cutting at School Road, Castlegar will be drawn back to either site compound SC 11/01 or SC 14/01. Vibration and noise monitoring will be required due to the proximity of residential and commercial properties (ref. **Chapter 17, Noise and Vibration**).

7.4.7.13 Section S13 School Road to Galway Racecourse Tunnel

This section consists of 1,800m of dual carriageway with one grade separated junction at the N83 Tuam Road. The mainline of the proposed road development will span over the N83 Tuam Road therefore temporary night time road closures may be required when constructing the overbridge once supporting structures and embankments have been built up on either side. Site access will be from the N83 Tuam Road. The nearest site compound is at Twomileditch (SC 14/01, SC 14/02 and SC 14/03) within the area of the N83 Tuam Road Junction.

At the N83 Tuam Road Junction the mainline will cut into a hill and remain in cut until the portal of the proposed Galway Racecourse Tunnel, therefore substantial material excavation will be required here. This excavated material can be reused if deemed suitable for the embankments on the mainline and slip lanes connecting to the Parkmore Link Road. The Parkmore Link Road and the City North Business Park Link will be constructed in advance of removing the existing access from the N83 Tuam Road to Galway Racecourse in order to maintain access.

The main structures in this section include one underbridge, one overbridge, one mammal underpass and one retaining wall. There are nine accommodation roads to be constructed and three drainage networks included in this section.

During the construction phase noise monitoring will be undertaken at the nearest sensitive locations to ensure construction noise limits (outlined in **Table 17.1** of **Chapter 17, Noise and Vibration**) are not exceeded.

Vibration monitoring will be undertaken at identified sensitive buildings, where proposed works have the potential to be at or exceed the vibration limit values. Baseline vibration monitoring will also be undertaken at potentially vibration sensitive activities for manufacturing facilities within the Parkmore and Racecourse Business Parks (ref. **Chapter 17, Noise and Vibration**).

7.4.7.14 Section S14 - Galway Racecourse Tunnel

A construction programme of works has been compiled in conjunction with Galway Racecourse to minimise the disruption to the commercial practice of the business throughout the year, not only for the racing festivals. An advance works schedule is included in this programme which includes two well relocations and associated infrastructure, water, telecoms, E-net and electrical utility diversions, access road realignments and replacement link roads. A 240m cut and cover tunnel will be constructed in phases over a three-year period with nine-month construction windows per year. Blasting of material will be required to remove shallow rock head which has been established from ground investigation work. Noise and vibration monitoring will be implemented due to the proximity of commercial and residential buildings in the area. A diversion of the main IDA surface water and foul sewer is required at the eastern portal of the tunnel. Material excavated will be tested for suitability for use in fill sections such as the Coolagh Junction.

Refer to **Appendix A.7.4** for further information regarding this construction sequence programme.

7.4.7.15 Section S15 - Galway Racecourse Tunnel to Coolagh Junction

There is a large amount of engineering fill required in this section due to the proposed overbridges and raised junction at Coolagh, Briarhill (ref. **Section 7.4.9** below). There are two underbridges, two overbridges, and two retaining walls included in this section. Two of the underbridge structures will be constructed over existing public roads (R336 Monivea Road and Briarhill Business Park Road) therefore it is envisaged that night time road closures will be required to construct beams once embankments and supporting structures have been constructed on either side.

Both retaining walls are in close proximity to two commercial properties therefore care will be required in construction of the walls to minimise disruption to the businesses as a result of the construction. Site compounds (SC 15/01 & SC 16/01) will be the main depots serving Section S14. See **Table 7.3** below for more information regarding the site compound locations. Access to the southern section will be provided from the R339 Monivea Road and access to the northern section will be from the Briarhill Business Park Road. Access to the north will be over R339 Monivea Road once the bridge has been constructed. Racecourse Avenue will be used as a haul route but will have restricted use. It will be used for delivery of materials only and will not be permitted for hauling excavated materials.

Traffic congestion at AM and PM peak times is a major issue at this location therefore contractors must ensure to minimise construction traffic movements at these times.

The main cuttings in this section include the eastern approach to the Galway Racecourse Tunnel and the connection with the existing N6 at Coolagh, Briarhill. Hard ripping using a hydraulic hammer or blasting will be required at these excavation locations due to the presence of shallow rock (ref. **Chapter 9, Soils and Geology**). There is also a risk of encountering a high water table in this area therefore, if encountered on site pumping will be implemented (ref. **Chapter 10, Hydrogeology**). There are six drainage networks in this section. (ref. **Chapter 5, Proposed Road Development** for description of drainage networks).

A Construction Traffic Management Plan is included in the CEMP in **Appendix A.7.5** and will be finalised and updated by the Contractor prior to construction. This plan will be complied with throughout construction for the sequencing of Coolagh Junction to ensure there is no major disruption to existing traffic.

7.4.8 Construction Methods

7.4.8.1 General

This section outlines the main construction activities and the associated methodologies that will be employed for the proposed road development. The following table is a high level summary of these methodologies which will use best practice methods in accordance with the relevant standards.

Table 7.2: Construction Activity Methodologies

Construction Activity	Construction Methodologies
Bulk Earthworks	Excavation works Drill and blast Rock crushing Fill
Cut and Cover Tunnel	Excavation Drill and blast Bottom up construction In-situ/precast Waterproofing Backfilling Mechanical & Electrical Ventilation Fire safety
Retaining Walls	Sheet Piling Anchors Rock Bolts Pins/Straps/Ties In situ casting
Mined Tunnel	Drill and blast Excavation Backfilling Supporting In-situ casting Waterproofing Mechanical & Electrical Ventilation Fire safety

Construction Activity	Construction Methodologies
Menlough Viaduct Construction	Limestone pavement protection system Pier construction (in-situ) Geotextile grid layer Floating beams
Bridge Construction	Pier construction (in-situ) Balanced cantilever beams

Detailed description of methodologies proposed for the construction of significant structures such as the River Corrib Bridge, Menlough Viaduct, Lackagh Tunnel and Galway Racecourse Tunnel are included in **Appendices A.7.1** to **A.7.4**.

7.4.8.2 Earthworks

Topsoil and subsoil will be excavated and replaced with road construction. Stripped topsoil and subsoil will be stored within the site boundary and reused within the construction of the proposed road development where feasible subject to testing to ensure it is suitable for its proposed end use. Where off-site storage is required for any period the contractor will ensure that these storage facilities have the appropriate waste licences or waste facility permits in place. All earthworks shall be managed having regard to the TII Guidelines for the Management of Waste from National Road Construction Projects.

Materials will be transported to and from the site using the existing road network. Excavation and filling will be carried out using mechanical plant.

Road embankments will be constructed using excavated material or, where necessary, imported fill material and will generally be compacted using static and vibrating rollers or similar equipment.

The embankments will be constructed for the majority from self-supporting fill material. Where during the detailed design, the requirement for soil retention is identified it shall be provided by using steepened earthworks which shall have a vegetated finish or reinforced soil or reinforced concrete retaining walls with a specified range of acceptable finishes to the exposed faces. The requirements for the aesthetic appearance of the exposed faces will be specified in the contract documents.

7.4.8.3 Pavement Works

Bituminous paving will be undertaken throughout the extent of the proposed road development. The thickness of the road pavement will be determined at detailed design stage but on this type of road, a new blacktop thickness of 350mm could be anticipated.

All new blacktop material will be transported to site in trucks designed for the transportation of materials at high temperatures. The material shall be transferred directly to paving machines, which spreads the blacktop onto the road in layers. The spread material is then compacted using rollers.

7.4.8.4 Environmental Management

Every reasonable effort will be made to ensure that any damaging environmental effects will be minimised during the construction phase of the proposed road development. The construction planning will be geared towards keeping disruption and nuisance to a minimum.

Environmental impacts during construction will be mitigated or reduced where possible (refer to the individual chapters in this EIAR for specific mitigation measures).

In this regard, prior to the commencing any works on site, the CEMP included in **Appendix A.7.5** of this EIAR will be finalised by the main contractor (Refer to **Section 7.4.1.1** above). Adherence to this plan will be a contract requirement and this will ensure good working practices are followed so as to minimise and manage any environmental impacts arising from construction.

7.4.9 Material Sources and Transportation

7.4.9.1 Overview

The earthworks operations will be a major activity on site and will include excavation, stockpiling, processing, deposition, blasting, material reuse, import and transportation from site for recovery/disposal. The construction of the proposed road development will require considerable movements of materials to, from and around the site. Most of the materials leaving the site will consist of hazardous material from the excavation works.

The current design of the proposed road development has an overall surplus of excavation material west of the River Corrib and an overall deficit of fill material east of the River Corrib, see below for details. All excavated material deemed to meet the required standards will be reused as part of the fill sections subject to testing to ensure it is suitable for its proposed end use.

If the proposed road development is to be constructed in phases as per **Section 7.4.2** above, then there will an overall surplus of 597,000m^3 in Phase 1 and overall deficit of 258,000 m^3 in Phase 2. Therefore, there will be a requirement to store excavated acceptable material from Phase 1 to balance the deficit in Phase 2. (Ref. **Section 7.4.9.2**). This material will be stored within the proposed development boundary in identified material deposition areas shown on **Figures 7.301** and **7.302**. All wastes which are not suitable for reuse within the proposed road development will be transported by authorised waste collectors in accordance with the Waste Management (Collection Permit) Regulations, 2007 as amended.

All wastes from the development will be delivered to authorised waste facilities in accordance with the Waste Management Acts 1996-2016. By only using facilities with the appropriate waste permits/licence, Galway County Council will condition the Contractor that he/she must comply with the objectives of the Waste Management Act and that any environmental emissions (noise, dust, water) are managed at the destination site and therefore are legally the responsibility of the owner/operator of the destination site. In this manner Galway County Council can be satisfied that the off-site spoil management aspect of the development is legally compliant with environmental and waste management legislation.

All traffic movements associated with the import or export of materials have been included in the construction traffic impact assessment. Materials required for the construction works will be sourced locally where possible. Materials required from quarries will only be sourced from quarries which are listed on the register maintained by the local authority. All material reused on site will be subject to testing to ensure it is suitable for its proposed end use.

There are operational quarries located in close proximity to the proposed road development. There is potential to import bituminous material for paving from one of these quarries. Haul routes have been identified to these quarries and any potential impacts associated with these haul routes have been assessed in this EIAR.

Rock crushing may be undertaken on site in order to make the excavated rock suitable for reuse as general fill. Otherwise it will be necessary to import crushed stone to site.

7.4.9.2 General Earthwork Quantities

In line with the principles of sustainable development, the proposed road development will seek to minimise the amount of materials brought into the construction site. This will be achieved by re-using as much of the materials generated during construction as possible subject to further testing to determine if materials meet the specific engineering standards for their proposed end-use.

Over 99% of excavated material generated by the proposed road development will be used to satisfy the necessary engineering, landscape and safety quantities required on the proposed road development.

The anticipated material which will be encountered along the proposed road development is provided below:

- **Acceptable Earthwork Material:** These can be categorised in accordance with TII Series 600 Table 6/1 Classes 1, 2, 6 and 8. They comprise the greater part of materials likely to be encountered, with their prescribed use provided in Table 6/1
- **Marginal Material:** Requires treatment such as addition of lime or air drying in order to meet acceptability requirements of TII Series 600. In terms of material being incorporated into the Works, the Contractor shall ensure, in advance, that the material is tested to ensure suitability for its proposed end use and that all pertinent legislation and guidelines are complied with. In addition, use of this material must be discussed with the Employers Representative in advance of any works
- **Topsoil:** Topsoil shall comply with requirements for Class 5 material as outlined in TII Series 600 Table 6/1
- **Peat:** In accordance with TII Series 600 Cl 601.2, non-hazardous peat shall be categorised as Unacceptable U1 material

- **U1 Soil:** Non-hazardous soil which does not comply with the requirements outlined in TII Series 600 Cl 601.1, shall be categorised as Unacceptable U1 material
- **U1 Rock:** Non-hazardous rock which does not comply with the requirements outlined in TII Series 600 Cl. 601.1, shall be categorised as Unacceptable U1 material
- **Hazardous Material:** Hazardous material, as defined in TII Series 600 Cl 601.3 shall be categorised as Unacceptable U2 material

Further information regarding the excavated material and general geology of the proposed road development can be found in **Chapter 9, Soils and Geology**.

A summary of the estimated quantities associated with the material requiring placement on-site and removal off-site are provided in **Table 7.3**. In addition to the material described in **Table 7.3** some services will be removed during excavation works including disused sewers, drains, cables, ducts, pipelines, disused basements, cellars and gullies.

A summary of the estimated quantities associated with the material requiring placement on-site and removal off-site are provided in **Table 7.3**.

Table 7.3: Estimated Excavation Material Volumes generated by Tunnelling and Road Construction

	Category (note 1)	**Estimated excavated material (m^3)**	**Estimated re-use within the proposed road development (m^3)**	**Estimated surplus excavated material requiring recovery/ disposal off site (m^3)**
Acceptable Earthworks Material	Classes 1, 2, 6 and 8	2,602,350	2,602,350	0
Marginal Material	Requires treatment in order to meet acceptability requirements	168,500	168,500	0
Topsoil	Class 5	151,450	151,450	0
Peat	Unacceptable category U1	76,000	76,000	
U1 Soil: Non-peat	Unacceptable Category U1	147,500	191,300	0
U1 Rock: Non-peat	Unacceptable Category U1	43,800		0
Landscaping and habitat creation	Class 4 (Note 2)	0		
Hazardous Material	Unacceptable Category U2	7,600	0	7,600
Total		**3,197,200**	**3,189,600**	**7,600**

Note 1: TII Series 600 including Table 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements.
Note 2: Landscape Fill in accordance with Class 4 of TII Series 600 including Table 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements.

In addition to the above excavation materials some services will be removed during excavation works including disused sewers, drains, cables, ducts, pipelines, disused basements, cellars and gullies.

A review has been undertaken of capacity at waste permitted and licenced facilities and this indicates that there is expected to be sufficient capacity within operational and planned waste management facilities to accept wastes generated by the proposed road development.

7.4.9.3 Potential Haul Routes

Potential haul routes have been identified across the proposed road development with aim of minimising interaction with the general public and creating as little disruption to the receiving environment as possible. Where possible haul routes will remain within the proposed development boundary with local road crossing points. However, there will be unavoidable periods where haul routes will require the use of public roads.

Haul routes along public roads have been identified taking cognisance of their current use, Average Annual Daily Traffic (AADT), non-motorised users (NMUS) such as pedestrians and cyclist and the current condition, width and alignment, in addition to their proximity to sensitive receptors. Where necessary flag men will operate at crossing points of junctions along haul routes to ensure safety of access and egress from the site of the proposed road development and site compounds. All haul routes along public roads will undergo a pre-structural assessment and any remediation works required will be put in place in advance of construction. Haul routes along public roads will be monitored for deterioration throughout construction and a structural assessment will be carried out to determine any sites requiring remediation work post construction. This arrangement has been successful in similar road schemes in the west such as the M17/M18 motorway scheme. A summary of the main haul routes are listed in **Table 7.4** below. Refer **Figures 7.101** to **124** for haul route locations.

Table 7.4: Haul Routes

Haul Route ID	Location & Chainage		Road Name(s)	Approximate Width	Road Description
	From	To			
HR 00/01	0+000 R336	1+150 Troscaigh Thiar	R336 and Bearna to Moycullen Road	6m within the proposed development boundary, 6m on Bearna/Moycullen Road and 9m on R336	The R336 is a regional road which runs through the village of Bearna. The road is in moderate-good condition and includes a footpath to the south for the length of the haul route and one footpath to the north in the village. The haul route identified along the R336 will then join the L-1321 Bearna to Moycullen Road at the signalised junction in Bearna Village. The L-1321 Bearna to Moycullen Road is a local road in moderate condition and includes footpaths within the Bearna Village environs.
HR 01/01	1+550 Troscaigh Thiar	4+440 Cappagh Road	Bearna/Moycullen Road, R336 and Cappagh Road	6m within the proposed development boundary, 6m on Bearna/Moycullen Road, 9m on R336 and 4.7-7.3m on Cappagh Road	The L-1321 Bearna to Moycullen Road is a local road in moderate condition and includes footpaths within the Bearna Village environs. The haul route along the L-1321 will join the R336 at the signalised junction in Bearna Village. The haul route continues along the R336, a regional road which runs through the village of Bearna, passing Bearna National School, towards Galway City. The road is in good condition and includes a footpath to the south for the length of the haul route and one footpath to the north in the village. The haul

Haul Route ID	Location & Chainage		Road Name(s)	Approximate Width	Road Description
	From	To			
					route joins Cappagh Road at the T-junction between Cappagh Road and the R336. Cappagh Road is a local road which is 7.3m wide and in good condition up to the Cappagh Road/Western Distributor Road Roundabout. From 100m north of the roundabout the road narrows to 4.3m and the road condition worsens. The southern section of Cappagh Road runs through a residential area and includes footpaths on either side. The northern section has footpaths on either side for the first 100m.
HR 04/01	4+450 Cappagh Road	8+500 N59 Dangan	Crossing Cappagh Road, Ballymoneen Road, Rahoon Road, Letteragh Road and access to N59	6m	To be constructed within the proposed development boundary.
HR 04/02	4+450 Cappagh Road	11+450 Kirwan Roundabout	R336, R337, R338 Bishop O'Donnell Road, R338 Seamus Quirke Road and N6	6m on R336 and R337. 9m on R338 Bishop O'Donnell Road. 15m on R338 Seamus Quirke Road. 15m on N6	This haul route links all haul routes to the west of the River Corrib with the haul routes on the east. The R336 is a regional road which runs towards Galway City. The road is in moderate-good condition and includes a footpath to the north for the length of the haul route. The R336 links into the R337 on Kingston Road. The R337 is a regional road which runs towards Galway City. The road is in moderate-good condition and includes a

Haul Route ID	Location & Chainage		Road Name(s)	Approximate Width	Road Description
	From	To			
					footpath to the north for the length of the haul route. The R337 links into the R338 Bishop O'Donnell Road at the signalised junction at the top of Threadneedle Road. The R338 Bishop O'Donnell Road is a regional road which runs towards the existing N6 national primary road. The road is in good condition and includes footpaths and cycle lanes on either side for the duration of the haul route. The R338 Bishop O'Donnell Road links into the R338 Seamus Quirke Road at the signalised junction with Circular Road. The R338 Seamus Quirke Road is a regional road which runs towards the existing N6 national primary road. The road is in good condition and includes footpaths, bus lanes and cycle lanes on either side for the duration of the haul route. The R338 Seamus Quirke Road ties into the N6 at Browne Roundabout. The existing N6 is a national primary route which includes two traffic lanes, raised cycle lanes and footpaths in either direction. The route is in good condition and links into the eastern haul routes at the Kirwan Roundabout.

Haul Route ID	Location & Chainage		Road Name(s)	Approximate Width	Road Description
	From	To			
HR 06/01	0+350 N59 Link	2+100 N59 Link	Crossing Letteragh Road and on Rahoon Road. Links into Bishop O'Donnell Road	6m inside development boundary. 9m on Rahoon Road	To be constructed within the proposed development boundary. Rahoon Road is a local road with footpaths on both sides for the length of the haul route. The road is in good condition for the length of the haul route.
HR 08/01	0+300 N59 Northern Link	9+250 Dangan	N59	9.2m on N59 6m inside the proposed development boundary	The N59 is a national secondary route with footpaths on either side of the identified haul route. The road is in good condition for the length of the haul route.
HR 09/01	9+400 Menlough & River Corrib Crossing	11+750 Coolough & Lackagh Quarry	Coolough Road	4.26 - 5.045m	Coolough Road is a local road which narrows north of Lackagh Quarry. The road is in poor condition with restricted views.
HR 11/01	11+450 Lackagh Quarry	12+550 N84 Junction	Coolough Road and N84	Coolough Road – 7.8m N84 - 8.5m	Coolough Road is a local road with footpaths on either side. The road was previously used by HGVs from Lackagh Quarry as a link to the national road network. The road is in moderate condition from Lackagh Quarry to the Kirwan Roundabout. The N84 is a national secondary route with footpaths on both sides for the majority of the identified haul route. The road is in good condition for the length of the haul route.

Haul Route ID	Location & Chainage		Road Name(s)	Approximate Width	Road Description
	From	To			
HR 11/02	11+850 Headford Road	13+150 School Road, Castlegar	Crossing N84	6m	To be constructed within the proposed development boundary.
HR 11/03	11+450 Lackagh Quarry	13+900 N83 Tuam Road	Coolough Road, N6 Bóthar Na dTreabh and N83 Tuam Road	Coolough Road – 7.8m, N6 Bóthar Na dTreabh – 14.2m N83 Tuam Road – 11.6m	Coolough Road is a local road with footpaths on either side. The road was previously used by HGVs from Lackagh Quarry as a link to the national road network. The road is in moderate condition from Lackagh Quarry to the Kirwan Roundabout. The existing N6 is a national primary route which includes two traffic lanes, raised cycle lanes and footpaths in either direction. The route is in good condition. The N83 is a national secondary route with footpaths on both sides for the majority of the identified haul route. The road is in good condition for the length of the haul route.
HR 13/01	13+150 School Road, Castlegar	14+950 N83 Junction & Racecourse Tunnel	Crossing, N83	6m	To be constructed within the proposed development boundary.
HR 14/01	14+000 N83 Tuam Road	17+450 Coolagh Junction	N6 Bóthar Na dTreabh – 14.2m	N6 Bóthar Na dTreabh – 14.2m	The existing N6 is a national primary route which includes two traffic lanes in each direction. There are raised cycle lanes and footpaths in either direction up to the Morris Junction. The route is in good condition.

Haul Route ID	Location & Chainage		Road Name(s)	Approximate Width	Road Description
	From	To			
HR 15/01	15+000 Ballybrit	17+450 Coolagh Junction	Crossing R339	6m	To be constructed within the proposed development boundary.
HR 15/02	15+500 Briarhill	15+950 Coolagh	Briarhill Business Park Road, Ballybrit Crescent and crossing R339	Briarhill Business Park Road - 7.1m Ballybrit Crescent -10.6m	The Briarhill Business Park Road is a commercial road which includes footpaths on either side. The road is in good condition and connects to Ballybrit Crescent at a T-junction. Ballybrit Crescent is a local road which includes footpaths on either side. The road is in good condition and terminates at the signalised junction at its intersection with the R339. Access along this route will be restricted to deliveries only.

7.4.9.4 Potential Site Compounds and Depots

There are thirteen sites identified as potential site compounds across the proposed road development. They have been identified at strategic locations across the proposed road development to minimise the distance for site construction traffic and personnel to travel. Sites identified have been chosen taking cognisance of proximity to major structures, excavations and embankments, proximity to residential properties, environmental constraints and current land use and ownership. Where possible site compound locations have been identified within the permanent proposed development boundary, there is one location which has been identified as a temporary acquisition for the purposes of construction and with ownership returned to the landowner post construction (SC 07/01). Larger area compounds have the potential for material stockpiling, crushing, regrading and delivery in tandem with site offices. No excavation works will be undertaken in site compounds in the granite area. Refer to **Table 7.5** below and **Figures 7.101** to **7.124** for potential site compound locations.

Table 7.5: Potential Site Compound Locations

Site No.	Location	Service Range (Chainage)		Approx. Site Area (ha)	Access	Main Construction Activities
		From	To			
SC 00/01	R336 Baile Nua	Ch. 0+000	Ch. 2+750	0.6	R336	Western tie-in for proposed road development
SC 04/01	Aille	Ch. 2+750	Ch. 4+100	0.4	Aille/ Cappagh Road	Aille Cutting, Rock Crushing Plant
SC 05/01	Ballymoneen	Ch. 5+250	Ch. 6+300	1.0	Cappagh Road	Aille Cutting, Letteragh and Rahoon Road Overbridges
SC 07/01	Letteragh	Ch. 6+300	Ch. 9+350	3.3	N59 Moycullen Road	Major cut at Letteragh Junction and River Corrib Bridge (western section) Rock Crushing & Regrading Plant
SC 08/01	Dangan (Aughnacurr a)	Ch. 8+550	Ch. 9+350	0.4	N59 Moycullen Road	River Corrib Bridge (western section). Used

Site No.	Location	Service Range (Chainage)		Approx. Site Area (ha)	Access	Main Construction Activities
		From	To			
						for storage only.
SC 09/01	Menlo (East of River Corrib)	Ch. 9+350	Ch. 10+450	0.9	Coolough Road	River Corrib Bridge (eastern section) & Menlough Viaduct
SC 11/01	Lackagh Quarry	Ch. 10+450	Ch. 13+900	9.0	Coolough Road	Lackagh Tunnel and potential for concrete batching plant, crushing and regrading of material.
SC 14/01	Twomileditch (N83 Junction)	Ch. 13+900	Ch. 14+700	1.6	N83 Tuam Road	N83/Parkmore Junction Rock Crushing Plant
SC 14/02	Twomileditch (N83 Junction)	Ch. 13+900	Ch. 14+700	0.9	Parkmore Link Road	N83/Parkmore Junction
SC 14/03	Twomileditch (N83 Junction)	Ch. 13+900	Ch. 14+700	0.8	Parkmore Link Road	N83/Parkmore Junction
SC 14/04	Western Racecourse Tunnel Portal	Ch. 14+700	Ch. 15+200	1.2	N83 Tuam Road	Galway Racecourse Tunnel (western section)
SC 15/01	Coolagh / Briarhill	Ch. 15+200	Ch. 16+100	0.5	R338 Monivea Road	Galway Racecourse Tunnel (eastern section)
SC 16/01	Coolagh	Ch. 16+100	Ch. 17+500	1.3	R338 Monivea Road	Coolagh Junction

7.4.9.5 Construction Traffic

An investigation of the construction traffic was carried out to determine the estimated vehicular movements required to transport the materials to and from construction zones. It should be noted that only registered vehicles will be allowed on public roads. **Table 7.6** below gives a summary of this assessment.

For the purposes of this assessment volumes were divided into seven zones:

- Zone 1 Ch. 0+000 - 3+900
- Zone 2 Ch. 3+900 - 7+750
- Zone 3 Ch. 7+750 - 9+300
- Zone 4 Ch. 9+300 - 11+140
- Zone 5 Ch. 11+140 - 14+140
- Zone 6 Ch. 14+140 - 16+200
- Zone 7 Ch. 16+200 - 17+550

In calculating this the following assumptions were made:

- 8 wheeler lorry for all road movements (capacity of 20 Tonne)
- 38 Tonne dumper for bulk earthworks
- No programme of works estimated – i.e. the number of estimated movements would be distributed over the construction period
- Import of non-site won material included e.g. concrete, pavement, Information Communication Technology (ICT)
- The construction period for Zones 1 to 3 is one year and for Zones 4 to 7 is three years

Table 7.6: Increase in HGV Percentage by Zone

Zone Reference	Location Reference	Existing Daily HGV's	Additional daily HGV's over construction period	Daily construction related AADT over construction period
Zone 1	R336	282	7	131
Zone 1	Bearna to Moycullen Road L1321	9	7	131
Zone 2	Cappagh Road	2	10	133
Zone 2	Seamus Quirke Road	480	16	264
Zone 2	Kingston Road	310	16	264
Zone 3	N59 at Hazel Park	103	10	59
Zone 3	N59 at Chestnut Lane	309	10	59
Summary of West	Quincentenary Bridge	1658	26	324
Zone 4	Bóthar Nua	17	51	110
Zone 5	N84 Headford Road at Ballinfoyle	501	10	58
Zone 5	N83 Tuam Road at City North Business Park	758	10	58
Zone 5	N6 Bóthar na dTreabh between N83 Tuam Road Junction and Morris Junction	1098	97	550
Zone 5	N6 Bóthar na dTreabh between N84 Headford Road Junction and N83 Tuam Road Junction	794	87	540
Zone 6	Parkmore Link Road at Business Park Junction 2	178	22	88
Zone 6	N6 Bóthar na dTreabh between Morris Junction and Lynch Junction	1364	119	638
Zone 7	N6 Bóthar na dTreabh at Ardaun	1350	124	684

Note: the above AADT figures include all construction related traffic such as demolition works, construction activities, delivery of goods and construction workers.

7.4.9.6 Traffic Safety

All construction works will be undertaken in a clearly delineated site area which will have specific entry and exit points for construction related traffic onto the public road network. Boundary treatment in the form of a fence will be erected prior to the commencement of construction and will define the extent of the construction site.

Where works are to be undertaken adjacent to the existing roads, temporary traffic barriers will be erected to separate the construction works from the public, to create a safe working space for the contractor and to clearly define the areas within which construction will be undertaken.

As has been stated above, traffic management will be required on the existing road networks during the construction of roads and structures. The contractor will be required to ensure safe operation of traffic at all times during the construction phase. Refer to Construction Traffic Management Plan Section 11 of the CEMP in **Appendix A.7.5**.

7.4.10 Services and Utility Requirements for Construction

7.4.10.1 Electricity

In liaison with the ESB Networks, a temporary transformer served from local supplies will be installed to provide the necessary power required at the various site compounds identified.

7.4.10.2 Water Supply

The construction activities requiring water during the construction phase will vary depending on the activity type. The initial estimate of demand is approximately $15m^3$ per day, primarily based on the demand requirement for the construction workers and the associated support facilities. However additional demand of water supply will be required for wheel washing facilities and requirements for construction activities such as drill and blast. In agreement with Irish Water, water will be sourced from the existing watermains at the most convenient point.

7.4.10.3 Storm Water and Foul Water Disposal

Storm water will be treated and managed carefully during construction. Storm water east of the River Corrib will be infiltrated to ground via silt traps and managed soakaways in the absence of public storm sewers. Storm water west of the River Corrib will be treated before being discharged to existing watercourses. The laydown areas will be suitably drained and any areas which will involve the storage of fuel and refuelling will be paved and bunded and hydrocarbon interceptors will be installed to ensure that no spillages will get into the surface water or groundwater (ref. **Chapter 10, Hydrogeology** and **Chapter 11, Hydrology**).

Prior to commencement of the main construction activities, a dedicated holding tank for storage of construction foul effluent will be constructed at compounds where welfare facilities are provided. This holding tank will be sealed to avoid any potential risk of spillage and contamination of the groundwater within this area. The effluent will be regularly disposed of off-site by tanker by a licensed contractor to an approved licenced facility (ref. Section 8 the CEMP in **Appendix A.7.5**).

7.4.11 Employment and Welfare

Through the construction phase there will be some variation in the numbers of staff working on site. It is anticipated there will be 250-270 staff directly employed on site across the proposed road development, rising to 300 staff at peak construction. Temporary office accommodation and other construction facilities will be installed on site for the construction phase. All temporary units will be of a high standard in accordance with statutory regulations, as a minimum. The co-ordination of people and materials on-site will be one of the key activities throughout the construction phases. The Construction Traffic Management Plan included in the CEMP in **Appendix A.7.5** includes designated traffic routes, timings and parking arrangements to be updated by the contractor prior to the commencement of construction.

The site start time will ensure that construction workers arrive to site prior to the morning peak hour for traffic on the local network.

Typical working hours during the construction phase will be:

Start	Finish	
0700	1900	Monday – Friday
0700	1600	Saturday (if required)

It will be necessary to work overtime (including weekends) and night shifts at certain critical stages during the project. There may be some periods where 24hr work and supervision is required. Consideration of safety, weather or sub-contractor availability is likely to necessitate working outside normal hours. Over the expected 36-month construction phase there will be up to 10 weeks of night time working. Heavy or noisy construction activities will be avoided outside normal hours and the amount of work outside normal hours will be strictly controlled.

7.4.12 Construction Health and Safety

7.4.12.1 Health and Safety

The requirements of the Safety, Health and Welfare at Work Act 2005, the Safety, Health and Welfare at Work (Construction) Regulations, 2013 and other relevant Irish and EU safety legislation will be complied with at all times.

As required by the Regulations, a Health and Safety Plan will be formulated which will address health and safety issues from the design stages through to the completions of the construction and maintenance phases. This plan will be reviewed as the development progresses. The contents of the Health and Safety Plan will follow the requirements of the Regulations.

In accordance with the Regulations, a "Project Supervisor Design Process" has been appointed and "Project Supervisor Construction Stage" will be appointed as appropriate.

The Project Supervisor Construction Stage will assemble the Safety File as the project progresses. The safety file will be incorporated into the overall technical record system at the end of project.

7.4.12.2 Fire Safety and Egress Design Strategy

The fire safety objectives adopted in the design will achieve compliance with the Building Regulations, particularly reference to Part B (Fire).

7.4.12.3 Construction Site Management and Security

There will be a contract management team on site for the duration of the construction phase. The team will supervise the construction of the works including monitoring the contractor's performance to ensure that the proposed construction phase mitigation measures are implemented and that construction impacts and nuisance are minimised.

7.4.12.4 Incident & Emergency Response Provisions

Appropriate site personnel will be trained as first aiders and fire marshals. In addition, appropriate staff will be trained in environmental issues and spill response procedures. Tanks and drums of potentially polluting materials will be stored in secure containers or compounds which will be locked when not in use. Secure valves will be provided on oil and fuel storage facilities. Equipment and vehicles will be locked, have keys removed and be stored in secure compounds.

The contractor will maintain an incident and emergency response action plan which will cover all foreseeable risks, i.e. fire, flood, collapse etc. An Incident Response Plan (IRP) is located in Section 10 of the CEMP in **Appendix A.7.5**.

The objective of this IRP is to:

- Ensure the health and safety of workers and visitors along the site
- Minimise any impacts to the environment and ensure protection of the water quality and the aquatic species dependent on it
- Minimise any impacts on properties, services etc.
- Establish procedures that enable personnel to respond to incidents with an integrated multi-departmental effort and in a manner that minimises the possibility of loss and reduces the potential for affecting health, property, and the environment

7.4.12.5 Site Security

The primary function of the sites security team will be to ensure that no unauthorised entry to site occurs. There will be fencing around the sites to minimise the risk of vandalism and unauthorised access. This process will be made easier by all operatives possessing and ID card. ID Cards will only be issued to operatives that have attended the site induction and (if relevant) a medical examination.

7.4.13 Commissioning Phase

If an east to west build is adopted, then it is likely that partial sections will be commissioned in phases e.g. N6 Coolagh Junction to N59 Letteragh Junction as part of Phase 1 and N59 Letteragh Junction to R336 west of Bearna as part of Phase 2 (Refer **Section 7.4.2** above).

Some sections could also be commissioned as part of an advance works contract e.g. Parkmore Link Road or the N59 Link Road North and South to alleviate existing traffic congestion problems. However, it is noted that if Parkmore Link Road were to be constructed separately as an advanced contract the cutting and overbridge structure for the mainline will need to be completed at the same time as it would be difficult to implement post construction with live traffic on the link road.

7.4.14 Construction Site Decommissioning

On completion of construction, all construction facilities and equipment such as plant, materials, signage, contractors' offices and laydown areas, etc. will be removed from site. All ground will be reinstated to an appropriate standard.

7.5 Potential Construction Impacts

The potential impacts identified in this section represent the "worst case" scenario predicted in the absence of any mitigation.

Potential construction impacts include emissions to air such as dust, noise and vibration, construction traffic (including oversized deliveries), surface water runoff from the site, leaks or spills from construction plant and equipment, construction waste and disruption to road users during the road upgrade. Additional traffic on the road network will be generated by the construction works. These potential impacts are assessed in the relevant chapters of this EIAR as outlined below.

There is also the potential for impacts on major existing services during construction such as the gas distribution main at Rahoon, gas transmission main at School Road, Castlegar, the 110kV overhead cables at Ballybrit and Coolagh, Briarhill, the IDA sewer at Parkmore and other services that are in conflict with the proposed road development. There will be temporary outages and disruption to the services as new connections are made and/or services are relocated. Refer to **Chapter 15, Material Assets (Non-agricultural)** for further information in relation to these potential impacts.

Potential impacts associated with the construction activities outlined above and in **Section 7.4** are also considered in other chapters of this EIAR as follows:

- Construction traffic (refer **Chapter 6, Traffic Assessment and Route Cross Section**)
- Flora and fauna (ref. **Chapter 8, Biodiversity**)
- Soils and geology (ref. **Chapter 9, Soils and Geology**)
- Hydrogeology (ref. **Chapter 10, Hydrogeology**)
- Hydrology (ref. **Chapter 11, Hydrology**)
- Visual impacts (ref. **Chapter 12, Landscape and Visual**)
- Archaeological, architectural and cultural heritage (ref. **Chapter 13, Archaeological, Architectural & Cultural Heritage**)
- Material Assets (ref. **Chapter 14, Material Assets Agriculture** and **Chapter 15, Material Assets Non-Agriculture**)
- Air quality and climate (ref. **Chapter 16, Air Quality and Climate**)
- Noise and vibration (ref. **Chapter 17, Noise and Vibration**)
- Human beings and health (ref. **Chapter 18, Human Beings, Population and Health**)

Specific construction mitigation measures are described in the individual chapters and general mitigation measures are described below.

7.6 Mitigation Measures

7.6.1 Construction Environmental Management Plan

Every effort will be made to ensure that any negative environmental effects will be avoided, prevented or reduced during the construction phase.

A Construction Environmental Management Plan (CEMP) has been prepared and is included in **Appendix A.7.5** which will be updated and finalised by the Contractor prior to construction commencing. The CEMP comprises all of the construction mitigation measures, which are set out in this EIAR, and will be updated with any additional measures which are required by the conditions attached to An Bord Pleanála’s decision. Implementation of the CEMP will ensure disruption and nuisance are kept to a minimum. The plan has regard to the guidance contained in the handbook published by Construction Industry Research and Information Association (CIRIA) in the UK, *Environmental Good Practice on Site Guide, 4th Edition* (CIRIA 2015). The plan also has regard to the TII Guidelines for the Creation, Implementation and Maintenance of an Environmental Operating Plan.

A construction management team shall be appointed for the duration of the construction phase. This team will supervise the construction of the proposed road development, including monitoring the performance of the contractors to ensure that the proposed construction phase mitigation measures are implemented and that construction impacts and nuisance are minimised. The construction management team will liaise with neighbours and the general community during the construction phase to ensure that any disturbance is kept to a minimum.

The CEMP summarises the overall environmental management strategy that will be adopted and implemented during the construction phase of the proposed road development. The purpose of the CEMP is to demonstrate how the proposed construction works can be delivered in a logical, sensible and safe sequence with the incorporation of specific environmental control measures relevant to construction works of this nature. The CEMP sets out the mechanism by which environmental protection is to be achieved during the construction phase of the proposed road development. Implementation of the CEMP will ensure disruption and nuisance are kept to a minimum.

The CEMP has been prepared in conjunction with the Environmental Impact Assessment (EIA) Report and Natura Impact Statement (NIS), having regard to consultations with a range of specialists and environmental organisations, in particular, the National Parks and Wildlife Service (NPWS) and Inland Fisheries Ireland (IFI). The CEMP supports the information already provided in this EIAR and must be read in conjunction with the information already provided in this EIAR.

The information included in the CEMP are presented below:

- General Project Details
- Contact Sheets
- Reference Documents
- Organisational Structure/Duties and Responsibilities
- Environmental Commitments and Environmental Control Measures
- Site Specific Method Statements/Management Plans
  - Construction and Demolition Waste Management Plan
  - Sediment, Erosion and Pollution Control Plan
  - Non-native Invasive Species Management Plan
  - Incident Response Plan
  - Construction Traffic Management Plan
  - Environmental Awareness Training Strategy
  - Communications Strategy
  - Inspections, Auditing and Monitoring Compliance Strategy
  - Final Handover

The CEMP is a working document and will be finalised by the Contractor following appointment and prior to commencing works on site. All of the content provided in this CEMP will be implemented in full by the Contractor and its finalisation by the Contractor will not affect the robustness and adequacy of the information presented and relied upon in this EIAR. Some information (such as project details and the schedule of environmental commitments from the EIAR) has already been provided in this EIAR and is not repeated in the version of the CEMP in **Appendix A.7.5**. However, it will be included in the CEMP which is finalised by the Contractor.

In addition to the items listed above, the following information will also be provided by the Contractor when finalising the CEMP:

- Planning Consent - If planning approval is granted for the proposed road development, the entire contents of the planning consent will be included in the CEMP
- Comprehensively incorporate all Environmental Commitments set out in the Contract documents (in particular the Works Requirements), those presented in this EIAR and any additional commitments which may arise as part of the development consent process up to and including the Oral Hearing. The CEMP will include the complete suite of Environmental Commitments together with the relative specification, evidence and responsibilities of how each commitment will be met
- Relevant Environmental Performance Criteria prescribed in environmental legislation and in Contract documents
- Register of all applicable legislation, including relevant standards, Codes of Practice and Guidelines
- Description of the Environmental Management System of the proposed road development, which shall be devised according to the criteria of ISO 14001:2004 – Environmental Management Systems. The CEMP will be complemented by General Procedures, Work Procedures and Operations Instructions. These documents will be in place within the site administration offices and appropriate site locations during works

The CEMP is a dynamic document and the Contractor will ensure that it remains up to date for the duration of the construction period. The CEMP may need to be altered during the lifecycle of the construction period to take account of monitoring results, legislative changes, outcomes of third-party consultations etc. Additional appendices may be added to the CEMP to accommodate monitoring results, permits etc. However, the finalisation of the CEMP by the Contractor will not affect the robustness and adequacy of the information presented here and relied upon in this EIAR.

In order to help ensure the successful development, implementation and maintenance of the CEMP, the Contractor will be obliged to appoint a Site Environmental Manager (SEM). The SEM will possess sufficient training, experience and knowledge appropriate to the nature of the task to be undertaken, a Level Eight qualification recognised by the Higher Education and Training Awards Council (HETAC), or a University equivalent, or other qualifications acceptable to the Employer, in Environmental Science or Environmental Management, or other subjects acceptable to the Employer. In particular, the SEM will require suitably qualified ecological experts to oversee ecologically sensitive elements of the construction works, ecological derogation licensing requirements and ecological monitoring. Further details on the roles and responsibilities of the SEM are provided throughout the CEMP in **Appendix A.7.5**.

The key Site Specific Method Statements/Management Plans of relevance to this EIAR are described below.

A **Construction & Demolition (C&D) Waste Management Plan (WMP)** has been prepared as part of the CEMP to ensure that waste arising during the construction and demolition phase of the proposed road development on site will be managed and disposed of in a way that ensures compliance with the provisions of the Waste Management (Amendment) Act, 1996- 2011 and associated Regulations (1996-2011) to ensure that optimum levels of reduction, re-use and recycling are achieved and to ensure that waste management does not impact on any European sites.

The **Sediment, Erosion and Pollution Control Plan (SEPCP**) summarises the procedures and technical practices for implementing effective sediment, erosion and pollution control through a variety of delivery methods for the construction phase of the proposed road development. The purpose of this SEPCP is to demonstrate at this stage, how the proposed construction works can be delivered in a logical, sensible and safe sequence with the incorporation of specific sediment, erosion and pollution control measures relevant to construction works of this nature.

A **Non-native Invasive Species Management Plan (NISMP)** has been prepared to outline the strategy that will be adopted during the construction and operation of the proposed road development in order to manage and prevent the spread of the non-native alien invasive plant species to any European sites. Refer to **Section 7.6.6** for further details.

The focus of including all of the stringent measures in this CEMP is on prevention of the incident arising in the first place. However, an Incident Response Plan (IRP) has been prepared to ensure that in the unlikely event of an incident, response efforts are prompt, efficient, and suitable for particular circumstances. The IRP describes the procedures, lines of authority and processes that will be followed to ensure that incident response efforts are prompt, efficient, and suitable for particular circumstances. The IRP details the procedures to be undertaken in the event of the release of any sediment into a watercourse, serious spillage of chemical, fuel or other hazardous wastes (e.g. concrete), non-compliance incident with any permit or license, or other such risks that could lead to a pollution incident, including flood risks.

All of the Contractor’s site staff will receive relevant and appropriate training to ensure that they have the appropriate knowledge to successfully implement the CEMP.

The CEMP also outlines the communications strategy which will be adopted during the construction phase which ensures that awareness, education and information sharing procedures are adopted and implemented. Finally, the CEMP outlines the inspections, auditing and monitoring compliance strategy that will be adopted by the Contractor.

7.6.2 Dust

Emissions to air during earthmoving and construction will occur, although the prevailing weather, the size of the site and its distance from sensitive receptors will assist in facilitating the management of any effects. The focus of the control procedures will therefore be to reduce the generation of airborne material.

The assessment of potential construction impacts includes for the implementation of ‘standard dust control measures’, as stated in the TII guidance. This shall include the following measures:

- Spraying of exposed earthwork activities and site haul roads during dry weather
- Provision of wheel washes at exit points
- Control of vehicle speeds and speed restrictions. It is proposed that site traffic is restricted to 20km/hr. This will help to minimise the occurrence of dust re-suspension
- Sweeping of hard surface roads

Additional measures, including dust screens will be implemented at locations where there is the potential for air quality impacts during the construction phase. Ref **Chapter 16, Air Quality and Climate, Section 16.5.3**. Employee awareness is also a most important way that dust may be controlled on any site. Staff training and the vigilant management of operations ensure that all dust suppression methods are implemented and continuously inspected.

Dust deposition monitoring will be conducted at a number of locations in the vicinity of the proposed road development. At least one month of dust deposition monitoring will be carried out in advance of the commencement of works to determine a baseline.

Refer to **Chapter 16, Air Quality and Climate** and Section 8 Sediment, Erosion and Pollution Control Plan of the CEMP in **Appendix A.7.5**, of this EIAR.

7.6.3 Debris

The following are some of the measures that will be taken to ensure that the construction site and surroundings are maintained to a high standard of cleanliness:

- Daily inspections will be undertaken to monitor tidiness
- A regular program of site tidying will be established to ensure a safe and orderly site
- If necessary, scaffolding will have debris netting attached to prevent materials and equipment being scattered by the wind
- Food waste will be strictly controlled on all parts of the site
- Wheel wash facilities will be provided for vehicles exiting the construction site. Wheel wash run off will be stored in an onsite storage tank and will be disposed of by permitted waste haulage company at a permitted or licensed facility
- In the unlikely event that mud is carried from the construction site to the public road, it will be cleaned as required and will not be allowed to accumulate
- Loaded lorries and skips will be covered if required
- Surrounding roads used by trucks for access to and egress from the site will be inspected regularly and cleaned, using an approved mechanical road sweeper, when required

- In the event of any fugitive solid waste escaping the site, it will be collected immediately and removed to storage on site, and subsequently disposed of in the normal manner

7.6.4 Noise and Vibration

Construction noise will be kept to a minimum in accordance with BS 5228 (2009). Potential construction noise impacts are addressed in **Chapter 17, Noise and Vibration** of this EIAR.

The contract documents will clearly specify that the contractor, undertaking the construction of the works, will be obliged to comply with the construction noise and vibration limits included in the EIAR. This will require specific noise abatement measures in line with the best practice measures outlined in British Standard BS 5228 – 1: 2009 +A1 2014: *Code of practice for noise and vibration control on construction and open sites – Noise* and the NRA (now TII) guidelines *Good Practice Guideline for the Treatment of Noise during the planning of National Road Schemes* (NRA 2014).

There will be areas of potential impacts due to construction noise on neighbouring residences. Prior to the construction works commencing on site, environmental noise monitors will be installed at the selected locations. Refer to **Chapter 17, Noise and Vibration** of this EIAR for further details.

It is anticipated that potential vibration will be generated during the construction phases of the proposed road development in areas of excavation which require drill and blasting. Prior to the construction works commencing on site, environmental vibration monitors will be installed at the selected locations. Refer to **Chapter 17, Noise and Vibration** of this EIAR for further details.

Piling is also likely to be required during the construction of the proposed road development. It will utilise methods that will minimise the risk of vibration being generated and will only be undertaken in daytime. Rock breaking, where required will use methods that will minimise noise and vibration. It will be necessary to conduct monitored trial blasts in the same bedrock formation as the proposed blast locations as part of the blast design assessment. The trial blasts will calibrate the blast design to site specific designs and will refine and validate the blast design properties. Trial blasts will not exceed the limitations of the local sensitive receptors. A liaison officer will be appointed by the contractor to notify residents and business in proximity to all blast sites in advance of this work. Locations of potential blasting are included on **Figures 7.201** to **7.202**.

7.6.5 Existing Services

The existing services running within and adjacent to the site and the proposed road development will be carefully located, identified and suitable working methods will be employed to ensure that these services are protected. Diversion or relocation of services will be undertaken in consultation with the owners of the services and in accordance with the relevant standards and codes of practice. Some protection measures such as cover slabs may be used for the services which will be left in place. Refer to **Chapter 15, Material Assets Non-Agricultural** for further details.

Service users will be notified in advance of any temporary disruption or outages necessitated by the construction works. The disruption to services or outages will be carefully planned so the duration is minimised.

7.6.6 Non-native Invasive Plant Species

Ecological surveys undertaken for this EIAR recorded 13 locations of invasive plant species at various locations along the route of the proposed road development (ref. **Chapter 8, Biodiversity**).

- Himalayan knotweed - *Persicaria wallichii* – 2 No. locations
- Japanese knotweed - *Fallopia japonica* – 8 No. locations
- Rhododendron - *Rhododendron ponticum* – 3 No locations

Refer to **Figure 8.15.1** to **8.15.14** for location details.

Japanese knotweed and Himalayan knotweed dispersal typically occurs through rhizome fragments being transported in soil by humans or to a lesser extent, through passive mechanical means such as in floodwaters. Dispersal is also achieved through vegetative reproduction from plant fragments. The plant typically occurs along roadsides, riverbanks and waste ground in Ireland where it forms dense, monotypic stands. During the winter, the brown stalks remain standing even though the plant dies back to the rootstock. Japanese knotweed causes a range of problems due to its prolific and dense growth habit including blocking sightlines on roads, damage to paving and structures, erosion of riverbanks and flood defence structures, damage to archaeological sites, loss and displacement of native habitats and species. Japanese knotweed is widespread throughout Ireland and is spreading rapidly.

Rhododendron ponticum is invasive in Ireland. It can spread via seed or can also occur by vegetative means where plants sucker or throw up new sprouts from roots as well as branches. It can withstand considerable shade and thrives as an understorey species in woodland, though it also tolerates open conditions in suitable acid soils. Its dense tangle of stems can block pathways, smother watercourses and encroach on roadways thereby impinging on sight-lines. The foliage of rhododendron contains various compounds that appear to have an allelopathic action on other species (inhibiting their growth) which may further inhibit plants from growing within close proximity.

At present, there are no specific legislative provisions that directly govern Japanese knotweed control or removal in Ireland. Every effort shall be made by the Local Authority to eradicate the non-native invasive species prior to award of the construction contract.

The contractor will have to put in place a management plan to treat/remove any invasive plant species which may require resurveying prior to construction in accordance with the CEMP in **Appendix A.7.5**. There is also the potential for non-native invasive plant species to be inadvertently brought onsite in imported fill or on the wheels/tracks of construction vehicles. The supplier of fill will be required to provide a guarantee that the fill to be imported does not contain non-native invasive plant species. In addition, the fill will be inspected for signs of non-native invasive plant species, prior to importation to site. The UK Environmental

Agency's publication *Managing Japanese knotweed on development sites - The Knotweed Code of Practice* (EA 2013), states that inspection of topsoil brought into the site, should be carried out using the guidance in appendix I-IV of the code BS 3882:2007 *The British Standard Specification for topsoil and requirements for use*. This Standard was replaced subsequently by BS3882:2015 *Specification for Topsoil*. The inspection of fill will be carried out according to this Standard.

The contractor will be required to inspect vehicles before using them on site, and will pay particular attention to caterpillar tracks and where trucks and dumpers are stowed.

A management plan for the control of non-native invasive plant species on the site during construction is included in the CEMP in **Appendix A.7.5** and was developed with reference to the following codes of practice and guidelines:

- Best Practice Management Guidelines Japanese knotweed Fallopia japonica (2008) - prepared for NIEA and NPWS as part of Invasive Species Ireland
- NRA Guidelines on The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads (2008)
- Managing Japanese knotweed on development sites - The Knotweed Code of Practice produced by the Environmental Agency

The implementation of the above measures will minimise the risk of Japanese Knotweed being spread within the site or to lands outside the site during the construction phase of the proposed road development.

A Non-native Invasive Species Management Plan is included in the CEMP in **Appendix A.7.5**.

7.6.7 Biodiversity

Potential impacts of the construction phase on biodiversity are addressed in **Chapter 8, Biodiversity** of this EIAR. Air and water pollution control measures are addressed in **Chapter 10, Hydrogeology**, **Chapter 11, Hydrology** and **Chapter 16, Air Quality and Climate**.

7.6.8 Waste Management

7.6.8.1 General

Waste generated during the construction phase will be carefully managed according to the accepted waste hierarchy which gives precedence to prevention, minimisation, reuse and recycling over disposal with energy recovery and finally disposal to landfill.

This hierarchy will be implemented by identifying opportunities to firstly prevent waste from being produced, and secondly minimise the amount of waste produced. Where prevention and minimisation will not be feasible, ways to reuse or recycle waste will be sought, preferably on-site to avoid the impacts arising from transportation. If this is not feasible, opportunities to reuse or recycle the waste off-site will be investigated or waste will be sent to an energy recovery facility, and only where there is no alternative, will waste be disposed of to landfill.

All waste removed from the site will be collected only by contractors with valid waste collection permits, under the Waste Management (Facility Permit and Registration) Regulations 2007 and (Amendment) Regulations 2008, 2014, 2015. All facilities to which waste will be taken will have appropriate waste licences or permits, under the Waste Management Act 1996, as amended, and the regulations thereunder, allowing them to accept the type of waste that is to be sent there. Hazardous waste generation will be minimised, and such waste will be recovered where feasible, and only disposed of if recovery is not feasible. Hazardous waste will be managed in accordance with the relevant legislation.

7.6.8.2 Resource and Waste Management

Surplus materials are likely to be generated as a result of demolition, excavation, construction and operation of the proposed road development.

Surplus materials generated during the following phases are addressed in this section:

- demolition phase
- excavation phase
- construction phase

There will also be operational waste from the proposed road development and it is likely to consist of road surface maintenance and landscaping wastes. Small quantities of operational waste are likely to be generated from the proposed road development. Contractors will be required to removed waste generated during works and deliver wastes to authorised waste facilities, for example waste permitted or EPA licenced facilities.

All wastes from the proposed road development will be delivered to authorised waste facilities in accordance with the Waste Management Acts 1996-2016. By only using facilities with the appropriate waste permits/licence, Galway County Council will be satisfied that the Contractor will comply with the objectives of the Waste Management Act and that any environmental emissions (noise, dust, water) are managed at the destination site and therefore are legally the responsibility of the owner/operator of the destination site. In this manner Galway County Council can be satisfied that the off-site spoil management aspect of the development is legally compliant with environmental and waste management legislation.

Demolition

An estimated 47,400 tonnes surplus demolition materials will be generated as a result of the proposed road development.

Excavation

An estimated 3,189,600m^3 excavated material will be reused within the proposed road development.

An estimated 15,200 tonnes (7,600m^3) waste will be generated as a result of the proposed road development.

Construction

In general, construction waste materials may include general construction debris, scrap timber and steel, machinery oils and chemical cleaning solutions. The practice of excessive purchase of materials and equipment to allow for anticipated wastage will be avoided.

The Building Research Establishment has published benchmark waste generation data from new build construction projects completed in the UK. Up to November 2009 a rate of 26.07m^3 waste / £100k was recorded in relation to civil engineering projects. Therefore, based on the estimated construction cost for the proposed road development an estimated 25,300 tonnes of construction waste will be generated.

7.6.8.3 Construction and Demolition Waste Management Plan for the Construction Phase

A Construction and Demolition Waste Management Plan is included in the CEMP in **Appendix A.7.5** to this report. This plan meets the requirements of the *Best Practice Guidelines for the Preparation of Waste Management Plans for Construction and Demolition Projects* (Department of Environment, Heritage & Local Government. 2006) and *TII Guidelines for the Management of Waste from National Road Construction Projects*. The contractor will be obliged to implement the Construction and Demolition Waste Management Plan.

7.6.9 Soil, Surface Water and Groundwater

There are several watercourses located along the route of proposed road development. The employment of good construction management practices will minimise the risk of pollution of soil, storm water run-off or groundwater. The Construction Industry Research and Information Association (CIRIA) in the UK has issued a guidance note on the control and management of water pollution from construction sites, *Control of Water Pollution from Construction Sites, guidance for consultants and contractors* (Masters-Williams et al 2001). Additional guidance is provided in the CIRIA technical guidance on *Control of Water Pollution from Linear Construction Projects* (Murnane *et al* 2006) and *TII Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes*.

Site activities considered in the guidance include the following:

- excavation
- earthmoving
- concreting operations
- spreading of topsoil
- road surfacing
- site drainage, and the control and discharge of surface water runoff from the site

- oil and fuel delivery and storage
- plant maintenance

Measures, as recommended in the guidance above, that will be implemented to minimise the risk of spills and contamination of soils and waters, include:

- Training of site managers, foremen and workforce, including all subcontractors, in pollution risks and preventative measures
- Careful consideration will be given to the location of any fuel storage facilities. These will be designed in accordance with guidelines produced by CIRIA, and will be fully bunded
- All vehicles and plant will be regularly inspected for fuel, oil and hydraulic fluid leaks. Suitable equipment to deal with spills will be maintained on site
- Where feasible, soil excavation will be completed during dry periods and undertaken with excavators and dump trucks. Topsoil and subsoil will not be mixed together
- Ensure that all areas where liquids are stored or cleaning is carried out are in a designated impermeable area that is isolated from the surrounding area, e.g. by a roll-over bund, raised kerb, ramps or stepped access
- Use collection systems to prevent any contaminated drainage entering surface water drains, watercourses or groundwater, or draining onto the land
- Minimise the use of cleaning chemicals
- Use trigger-operated spray guns, with automatic water-supply cut-off
- Use settlement lagoons or suitable absorbent material such as flocculent to remove suspended solids such as mud and silt
- Ensure that all staff are trained and follow vehicle cleaning procedures. Post details of the procedures in the work area for easy reference

Refer also to the Sediment, Erosion and Pollution Control Plan included in the CEMP in **Appendix A.7.5**, **Chapter 10, Hydrogeology** and **Chapter 11, Hydrology**.

7.7 Residual Impacts

There will be little or no residual impacts as a result of the proposed construction activities. As described above the main impacts will be during the construction period. Any residual impacts to the existing environment such as deterioration of public roads used as haul routes will be repaired. Any structural damage caused to buildings/structures/wells as a result of the construction will undergo a full stabilisation and rehabilitation works. The residual impacts of the other construction related activities of the proposed road development are assessed in the relevant chapters of this EIAR.

7.8 Summary

An overall construction period of 36 months is anticipated for the construction of this proposed road development. It is envisaged that the construction will be phased and potentially in an east to west build with the sections outlined in **Section 7.4.7**. These sections can run concurrently and combined where feasible. Potential haul routes and site compound locations have been identified taking cognisance of potential impacts to existing environment and proximity to major structures along the proposed road development. Construction methods employed will be in accordance with best practice standards and guidelines. All necessary precautions and mitigation measures to reduce the potential impacts of the construction activities to the environment will be implemented. Management plans will be put in place to mitigate impacts such as dust, debris, noise and vibration, service diversions, non-native invasive plant species and waste.

7.9 References

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- National Roads Authority. (2014) *Good Practice Guideline for the Treatment of Noise during the planning of National Road Schemes,* NRA, Dublin.
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8 Biodiversity

8.0 Executive Summary

This chapter presents an assessment of the likely significant effects of the proposed road development on the receiving biodiversity environment. Given the considerable level of detail contained in this assessment, a summary is first presented to give an overview and assist in an understanding of this chapter. Alongside the term "biodiversity", the terms "ecology" and "ecological" are also used throughout this chapter as a broader term to refer to the relationships of biodiversity receptors to one another and to their environment.

The collation of the biodiversity baseline data and the preparation of this chapter has had regard to current legislation relating to biodiversity protection and current best practice guidance documents on valuing biodiversity receptors and impact assessment - both for the purposes of EIA and AA.

A desktop study was carried out to inform the initial scope of the ecological surveys required for the environmental impact assessment. The desktop study involved collection and review of relevant published and unpublished sources of data, collation of existing information on the ecological environment and consultation with relevant statutory bodies (e.g. National Parks & Wildlife Service (NPWS) and Inland Fisheries Ireland (IFI)).

A comprehensive range of field surveys were carried out between 2013 and 2018 to inform the impact assessment. These included habitat surveys, surveys for protected plant species, mammal surveys (including dedicated surveys for Otter, Badger and bats), White-clawed crayfish surveys, molluscan surveys (including Freshwater pearl mussel and *Vertigo* snail species surveys), Marsh fritillary butterfly surveys, breeding and wintering bird surveys (including dedicated Barn owl, Peregrine falcon, Red grouse and Woodcock surveys), amphibian surveys, Common lizard surveys and fish surveys (including assessment of biological water quality status).

Each of the sections below provides a summary for each of the key ecological receptors (KERs[1]) in the receiving environment. These summaries include an overview of the baseline, the likely impacts of the proposed road development and the mitigation measures proposed to avoid or minimise the predicted impacts, including a monitoring[2] programme where relevant, the residual impacts remaining, and (where relevant) any compensation measures proposed to further address those residual impacts. Where used below, the term Zone of Influence (ZoI) refers to the area within which the proposed road development could affect the receiving biodiversity environment as a consequence of a particular potential impact.

[1]KERs are those biodiversity receptors within the ZoI of the proposed road development which are "both of sufficient value to be material in decision making and likely to be affected significantly" i.e. with an ecological value of local importance (higher value) or greater.

[2] In accordance with the requirement for monitoring set out in the EIA Directive 2014/52/EU to monitor significant effects on the environment

The KER summaries are divided into the following headings for ease of reading:

- Designed areas for nature conservation:
    - European sites (cSAC & SPA)
    - Natural Heritage Areas (NHA)
    - Proposed Natural Heritage Areas (pNHA)
- Habitats
- Rare and protected species
- Otter
- Bats
- Badger
- Other Mammal Species
- Mollusc species
- Marsh fritillary butterfly
- Breeding birds
- Wintering birds
- Amphibians
- Reptiles
- Fish

Local biodiversity areas, as defined in the *Galway City Development Plan 2017–2023* and the most recent draft of the *Galway City Biodiversity Action Plan 2014–2024* are also considered. Local biodiversity areas provide habitat for a range of species with the River Corrib corridor providing an important link between Galway Bay and the mosaic of habitats surrounding the city, which includes the wetland complex associated with Lough Corrib. The local biodivsersity areas that lie within the zone of influence of the proposed road development are:

- Rusheen Bay – Barna Woods – Illaunafamona
- Cappagh – Ballymoneen
- Ballagh – Barnacranny Hill
- River Corrib and adjoining wetlands
- Menlough to Coolough Hill
- Ballindooley – Castlegar (which is linked to the River Corrib by the Terryland River)
- Galway Racecourse, Ballybrit
- Doughiska
- Mutton Island and nearby shoreline

8.0.1 Designed areas for nature conservation

8.0.1.1 European sites – (candidate) Special Areas of Conservation ((c)SACs) and Special Protection Areas (SPAs)

There are four European sites within the ZoI of the proposed road development: Lough Corrib cSAC is traversed by the proposed road development, with Lough Corrib SPA located upstream and Galway Bay Complex cSAC and Inner Galway Bay SPA downstream of the proposed road development. There are no other European sites at risk of impacts from the proposed road development.

The potential impacts associated with the proposed road development, how these might affect the European sites' conservation objectives, and the mitigation measures that will be implemented to ensure that adverse effects on site integrity do not arise, are considered and assessed in full detail in the Natura Impact Statement (NIS). The conclusion of the NIS assessment was that the proposed road development will not adversely affect the integrity of any European site, either alone or in combination with other plans or projects.

The proposed road development will, however, have a residual biodiversity effect on Lough Corrib cSAC locally, as there will be permanent habitat losses and long-term effects on local bat populations[3] that use habitats within the European site. None of these impacts will affect the site's conservation objectives or adversely affect the integrity of Lough Corrib cSAC and therefore, the proposed road development will not result in a likely significant residual effect on any European sites.

The European sites are discussed in detail below with the receiving environment in **Section 8.3.3**; evaluation of impacts in **Section 8.5.3**; proposed mitigation measures in **Section 8.6.1** and residual impacts in **Section 8.7.1**.

8.0.1.2 Natural Heritage Areas (NHAs) and proposed Natural Heritage Areas (pNHAs)

Moycullen Bogs NHA lies immediately adjacent to the proposed road development at Tonabrocky and is the only NHA site within the ZoI of the proposed road development.

The potential impacts associated with the proposed road development on Moycullen Bogs NHA include the deposition of dust during construction, the introduction of non-native invasive plant species and surface water impacts during construction. Moycullen Bogs NHA is beyond the ZoI of any hydrogeological effects from the proposed road development. Mitigation measures will be implemented to ensure that the proposed road development does not affect habitats

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[3] The Menlough Lesser horseshoe bat population is not connected to the Eborhall Lesser horseshoe bat population, which is the qualifying interest (QI) population for Lough Corrib cSAC. Any predicted impacts on Lesser horseshoe bats associated with the proposed road development will not affect the conservation objectives of the Lough Corrib cSACs QI Lesser horseshoe bat population.

and species in Moycullen Bogs NHA via these impacts. Therefore, the proposed road development will not result in likely significant residual effects on the NHA.

There are only two pNHA sites within the ZoI of the proposed road development: Lough Corrib pNHA and Galway bay Complex pNHA.

Lough Corrib pNHA is traversed by the proposed road development at the River Corrib Bridge crossing. The potential impacts associated with the proposed road development on this pNHA site are generally as per those discussed in the NIS in relation to Lough Corrib cSAC and Lough Corrib SPA – habitat loss, surface water impacts during construction, deposition of dust during construction, the introduction of non-native invasive plant species, hydrogeological impacts and mortality risk to aquatic species. However, the zone within which the proposed road development directly interacts with Lough Corrib pNHA is much smaller than that directly affected within Lough Corrib cSAC, and is limited to the River Corrib channel and banks at the proposed River Corrib Bridge. Mitigation measures will be implemented to avoid and minimise effects on biodiversity receptors in the receiving environment. As with Lough Corrib cSAC, although there will be some level of residual impact in the vicinity of the River Corrib this is not likely to affect the integrity of Lough Corrib pNHA.

Galway Bay Complex pNHA lies downstream of the proposed road development where it crosses the Bearna Stream catchment, the Knocknacarra Stream catchment and the River Corrib. The potential impacts associated with the proposed road development on this pNHA site are generally as per those discussed in the NIS in relation to Galway Bay Complex cSAC and Inner Galway Bay SPA - surface water impacts during construction, the introduction of non-native invasive plant species, barrier effect and mortality risk to aquatic species, affecting groundwater and disturbing wintering birds at important wetland sites (e.g. Ballindooley Lough). Mitigation measures will be implemented to ensure that the proposed road development will not result in likely significant residual effects on the pNHA via these impacts.

Therefore, the proposed road development will not result in likely significant residual effects on pNHAs.

The NHA and pNHA sites are discussed in detail below with the receiving environment in **Section 8.3.3**; evaluation of impacts in **Section 8.5.3**; proposed mitigation measures in **Section 8.6.1** and residual impacts in **Section 8.7.1**.

8.0.2 Habitats

West of the River Corrib, outside of the built environment, habitats recorded during the surveys generally consisted of a mosaic of agricultural fields, peatland/heath habitats, and scrub; separated into distinct habitat blocks of varying sizes by the local road network and the associated linear residential development. The peatland habitat blocks consisted of predominantly wet heath, dry heath and bog habitat mosaics.

The area from the River Corrib to the N84 Headford Road comprised of a patchwork of semi-natural woodland, limestone pavement, scrub and calcareous grassland fields. East of the N84 Headford Road, habitats comprised of predominantly improved agricultural grasslands surrounded by residential and industrial development in Parkmore, Ballybrit, Briarhill and Doughiska, although there were some isolated patches of semi-natural habitats – calcareous grassland and limestone pavement – in the Coolagh/Doughiska area. There were also two wetland complexes of note: at the Coolagh Lakes and at Ballindooley Lough.

Non-native invasive plant species (Japanese knotweed, Himalayan knotweed and Rhododendron) were recorded in dispersed locations across the study area.

The following Annex I habitats were recorded within, or adjacent to, the proposed development boundary: Hard water lakes [3140], Turloughs [*3180], Petrifying springs [*7220], Residual alluvial forests [*91E0], Limestone pavement [*8240], Wet heath [4010], Dry heath [4030], Calcareous grassland [*6210/6210], *Molinia* meadow [6410], Blanket bog (active) [*7130], *Cladium* fen [*7210], and Alkaline fen [7230].

The potential impacts of the proposed road development are loss of habitat, habitat fragmentation, and habitat degradation through effects on surface water quality, groundwater, deposition of dust during construction, the introduction of non-native invasive plant species and the structural stability of rock around tunnels and deep excavations/cuttings.

Mitigation measures will be implemented to protect surface water quality and groundwater in the receiving environment, control dust emissions from the construction site, control and prevent the spread of non-native invasive plant species, ensure that tunnelling and deep excavations do not affect the structural integrity of the surrounding rock mass, and to minimise habitat losses within the proposed development boundary.

However, the permanent losses of the following habitats will result in a likely significant negative residual effect at geographic scales ranging from local to international: a Petrifying spring feature at Lackagh Quarry, c.0.1ha of Residual alluvial forest habitat, c.0.54ha of Limestone pavement habitat, c.2.06ha of Wet heath habitat, c.1.85ha of Dry heath habitat, c.0.87ha of Wet heath/Dry heath/*Molinia* habitat mosaic, c.0.7ha of Calcareous grassland habitat (non-priority), c.0.28ha of *Molinia* meadow habitat, fifteen calcareous spring features (FP1), c.7.81ha of dry-humid acid grassland habitat, c.0.13ha of poor fen and flush (PF2) habitat, c.2.62ha of (mixed) broadleaved woodland (WD1), c.7.8km of hedgerows (WL1) and c.4km of treelines.

Compensatory habitat will be provided to replace the areas of Residual alluvial forest (c.0.18ha), Dry heath (c.7.06ha), Calcareous grassland (c.7.14ha), *Molinia* meadow (0.49ha), (mixed) broadleaved woodland (> 2.62ha), hedgerows (> 7.8km) and treelines (> 4km) by providing a greater area to that being permanently lost to the proposed road development.

However, some of the Annex I habitat types that are being lost, outside of any European sites, cannot be directly compensated. Therefore, there will be a likely significant residual negative effect at the international geographic scale for the permanent loss of c.0.54ha of Limestone pavement, at the national geographic scale for the permanent loss of c.2.93ha of Wet heath and wet heath mosaic habitat, at the county geographic scale for the loss of a Petrifying spring feature at Lackagh

Quarry, and at the local geographic scale for the permanent loss of 15 calcareous springs at Lackagh Quarry, c.7.81ha of dry-humid acid grassland and c.0.13ha of poor fen and flush habitat. The Annex I habitat impacts are summarised in **Table 8.0** below.

Table 8.0: Summary of Annex I Habitat Impacts

Annex I habitat type	**Area Potentially Impacted**	**Area to be Retained**	**Permanent area of habitat loss**	**Area of Compensatory Habitat**	**Residual Habitat Loss**
Turlough [*3180]	c.0.04ha within proposed development boundary[4]	All	None	n/a	None
Petrifying springs [*7220]	Two Petrifying spring features at Lackagh Quarry	One feature to be retained	One Petrifying spring feature	n/a	One Petrifying spring feature
Residual alluvial forest [*91E0]	c.0.1ha	None	c.0.1ha	c.0.18ha	None
Limestone pavement [*8240]	c.2.18ha	c.1.64ha	c.0.54ha	n/a	c.0.54ha
Limestone pavement/Calcareous grassland [*8240/6210] Above Lackagh Tunnel	c.0.12ha	All	None	n/a	None
Wet heath [4010]	c.2.06ha	None	c.2.06ha	n/a	c.2.06ha
Dry heath [4030]	c.1.96ha	c.0.11ha	c.1.85ha	c.7.06ha	None
Wet heath/Dry heath/*Molinia* mosaic [4010/4030/6410]	c.1.13ha	c.0.26ha	c.0.87ha	n/a	c.0.87ha
Calcareous grassland [6210]	c.1.14ha	c.0.44ha	c.0.7ha	c.7.14ha	None
Molinia meadow [6410]	c.1.02ha	c.0.74ha	c.0.28ha	c.0.49ha	None

Habitats are discussed in detail below with the receiving environment in **Section 8.3.4** and **8.3.6** (for non-native invasive plants); evaluation of impacts in **Section 8.5.4**; proposed mitigation measures in **Section 8.6.2** to **8.6.6**; residual impacts in **Section 8.7.2** and proposed compensatory measures in **Section 8.9.1**.

[4] Total area of Turlough is c.0.1ha

8.0.3 Rare and protected plant species

There are no rare or legally protected plant species present within the proposed development boundary or known from areas within the ZoI of the proposed road development. Therefore, the proposed road development will not result in likely significant residual effects on rare or legally protected plant species.

Rare and protected plant species are discussed in detail below with the receiving environment in **Section 8.3.5**; evaluation of impacts in **Section 8.5.5** and residual impacts in **Section 8.7.3**.

8.0.4 Otter

Otter, and their breeding and resting places, are protected under the Wildlife Acts. Otter are also listed on Annex II and Annex IV of the EU Habitats Directive. Evidence of Otter activity was abundant and widespread along the River Corrib corridor and the south-eastern shore of Lough Corrib. Otter were also recorded in the catchment of the Bearna Stream and the Tonabrocky Stream. There were no Otter holt or couch sites within the ZoI of the proposed road development.

The proposed road development will result in the loss of a small area of Otter habitat, it may pose a temporary habitat severance/barrier effect, and will result in some level of disturbance to Otter during construction and operation. However, this will not result in any long-term effects on the local Otter population. During operation, the combination of the network of wildlife passage facilities, culverts, bridges and viaduct structures (e.g. the proposed River Corrib Bridge and the Menlough Viaduct), and the mammal fencing, will reduce any long-term severance or barrier effects and the mortality risk associated with the proposed road development, such that the local Otter population will not be negatively affected. The effectiveness of the mitigation measures will be monitored post-construction.

Therefore, the proposed road development will not result in likely significant residual effects on the local Otter population.

Otter are discussed in detail below with the receiving environment in **Section 8.3.7.1**; evaluation of impacts in **Section 8.5.6.1**; proposed mitigation measures in **Section 8.6.7.1** and residual impacts in **Section 8.7.4.1**.

8.0.5 Bats

Bats, and their breeding and resting places, are protected under the Wildlife Acts. All bat species are also listed on Annex IV of the Habitats Directive; with the Lesser horseshoe bat also listed on Annex II. The following bat species were recorded locally during the field surveys: the Lesser horseshoe bat, Leisler’s bat, the Common pipistrelle bat, the Soprano pipistrelle bat, Nathusius’ pipistrelle bat, the Brown long-eared bat, Daubenton’s bat, Natterer’s bat and the Whiskered bat. A total of 88 roost sites were recorded within the local area during the field surveys.

The local Lesser horseshoe population is of particular importance given its Annex II status and the importance of the local area as a stepping-stone for the species between Lesser horseshoe bat populations in north Galway/south Mayo and south

Galway/Clare [5]. The maternity/hibernation roost at Menlo Castle and the mating/hibernation roost at Cooper's Cave in Castlegar are key roost sites for the Menlough Lesser horseshoe bat population, which are also supported by a network of smaller day/night roost sites across the local area. The foraging habitat surrounding the maternity roost is vital in supporting the local Lesser horseshoe bat population, as is the extent of foraging habitat and the commuting routes that connect the landscape between those key roost sites at Menlo Castle and Cooper's Cave. Although the proposed road development does not directly affect either the Menlo Castle or Cooper's Cave roosts, it will affect three Lesser horseshoe bat roost sites used by the Menlough population, will result in habitat loss within their foraging area (including in the vicinity of the maternity roost), and will present a barrier to movement between the maternity, mating and hibernation roost sites.

Fifteen buildings which support 20 bat roosts are within the proposed development boundary:

- six Soprano pipistrelle roosts
- one Common pipistrelle roost
- one unidentified Pipistrelle species bat roost
- seven Brown long-eared bats roost
- three Lesser horseshoe bat roosts
- two roosts of unidentified bat species

Fourteen of these buildings will be demolished with one (a Soprano pipistrelle roost) being retained.

Two of the trees along the proposed road development with a high potential to support roosting bats were confirmed as roosting sites, and will be removed:

- one Leisler's bat roost
- one Soprano pipistrelle roost

During construction, the proposed road development will also result in the loss of foraging habitat, habitat severance will affect bat commuting routes, habitat loss will present a barrier to bat flight paths, construction works will cause disturbance to roost sites, and lighting will disturb foraging and commuting bats.

During operation, the proposed road development will present a permanent mortality risk to the local bat populations, will permanently sever bat habitat and commuting routes and present a barrier to bat movements at a landscape scale. Operational lighting will also disturb and displace bats.

Mitigation measures will be implemented during construction to protect bats during building demolitions and tree removal and to preserve flight paths across the construction site. During operation, a series of underpasses and the Castlegar

[5] The Menlough Lesser horseshoe bat population is not connected to the Eborhall Lesser horseshoe bat population, which is the qualifying interest (QI) population for Lough Corrib cSAC. Any predicted impacts on Lesser horseshoe bats associated with the proposed road development will not affect the conservation objectives of the Lough Corrib cSACs QI Lesser horseshoe bat population.

Wildlife Overpass will be installed to allow bats to cross the proposed road development away from traffic, reducing the mortality risk and any permanent barrier effects. The lighting design has minimised the disturbance and displacement effects on bats during operation. The mitigation strategy includes pre-construction monitoring and monitoring of the effectiveness of the mitigation measures during and post-construction.

Despite the implementation of these mitigation measures there will be a significant residual effect on the local Lesser horseshoe bat population at the national geographic scale (given the importance of the local population), and on all other bat species at the local geographic scale.

To further reduce the effects of the residual impacts on the local bat populations, compensation measures are also proposed. These measures are:

- the provision of new roosting sites (new buildings, buildings retrofitted to create roost sites and bat boxes)
- measures to protect these roosts during construction
- and habitat enhancement measures (e.g. planting)

The effectiveness of the mitigation measures will be monitored as part of the monitoring programme.

With the compensation measures implemented the residual impacts of the proposed road development on bats will be reduced from a likely significant residual negative effect on the local bat populations at the national geographic scale to a local geographic scale.

Bats are discussed in detail below with the receiving environment in **Section 8.3.7.2**; evaluation of impacts in **Section 8.5.6.2**; proposed mitigation measures in **Section 8.6.7.2**; residual impacts in **Section 8.7.4.2** and proposed compensatory measures in **Section 8.9.2**.

8.0.6 Badger

Badger are protected under the Wildlife Acts and were recorded across the study area from Na Foraí Maola to the N83 Tuam Road. The highest concentrations of badger activity were recorded in the Menlough area and the area between Lackagh Quarry and the N84 Headford Road. A total of 17 badger setts were identified both within and in the vicinity of the study area.

Although the proposed road development will result in the loss of foraging habitat and disturbance due to light spill during operation, these impacts will not result in any long-term effects on the local population. The proposed road development will result in the loss of three badger setts, which includes the main and a subsidiary sett of one badger group at Lackagh. An artificial badger sett will be provided to reduce the effects of sett loss on this badger group.

Mitigation measures will also be implemented during construction to minimise the effects of disturbance on the local badger population and to avoid badgers being killed during sett removal. During operation, the combination of the network of wildlife passage facilities, culverts, bridges and viaduct structures (e.g. the proposed River Corrib Bridge and the Menlough Viaduct), and mammal fencing will reduce any long-term severance or barrier effects and the mortality risk associated with the proposed road development, such that the local Badger population will not be negatively affected. The effectiveness of the mitigation measures will be monitored post-construction.

Therefore, the proposed road development will not result in likely significant residual effects on the local Badger population.

Badgers are discussed in detail below with the receiving environment in **Section 8.3.7.3**; evaluation of impacts in **Section 8.5.6.3**; proposed mitigation measures in **Section 8.6.7.3** and residual impacts in **Section 8.7.4.3**.

8.0.7 Other Mammal Species

The following terrestrial mammal species protected under the Wildlife Acts were recorded, or are known, from the area surrounding the proposed road development:

- Pine marten
- Wood mouse
- Red squirrel
- Irish stoat
- Irish hare
- Hedgehog
- Pygmy shrew

Fox, Rabbit, Mink and Bank vole were also recorded during the field surveys.

Although the proposed road development will result in the loss of foraging habitat for these mammals, will present a low level of mortality risk and will result in disturbance/displacement effects, these impacts will not result in any long-term effects on local populations.

During operation, the combination of the network of wildlife passage facilities, culverts, bridges and viaduct structures (e.g. the proposed River Corrib Bridge and the Menlough Viaduct) will reduce any long-term severance or barrier effects associated with the proposed road development such that the local populations of these mammal species will not be negatively affected.

Harbour seal, Grey seal, Common dolphin and Harbour porpoise are known from Galway Bay and these species are all protected under the Wildlife Acts – both seal species are also listed on Annex II of the habitats directive and all cetacean species are listed on Annex IV of the Habitats Directive.

Mitigation measures will be implemented to ensure that the proposed road development will not affect water quality in the receiving aquatic or marine environments and therefore, will not affect the marine mammal populations in Galway Bay.

Therefore, the proposed road development will not result in likely significant residual effects on these terrestrial or marine mammal species.

These species are discussed in detail below with the receiving environment in **Section 8.3.7.4**; evaluation of impacts in **Section 8.5.6.4**; proposed mitigation measures in **Section 8.6.7.4** and residual impacts in **Section 8.7.4.4**.

8.0.8 Mollusc species

Neither the White-clawed crayfish, the Freshwater pearl mussel, nor any other legally protected mollusc species, were recorded within the ZoI of the proposed road development.

There is a Freshwater pearl mussel population in the Owenriff River (c.23km to the north, at Oughterard, Co. Galway) which the proposed road development could affect indirectly through impacting on salmonid fish populations in the River Corrib. This was considered and assessed in the NIS, as the Owenriff population are the qualifying interest population for Lough Corrib cSAC. The conclusion of this assessment was that, considering the mitigation measures to protect the aquatic environment, the proposed road development would not affect salmonid fish species in the receiving environment and therefore not affect that Freshwater pearl mussel population.

The Marsh whorl snail is listed as vulnerable in the Irish Red Data List of molluscs (Byrne *et al*., 2009) and was recorded in wetland habitat along the River Corrib, in fringing wetland habitat at the Coolagh Lakes, at Ballindooley Lough and at the marsh in Castlegar. Although the proposed road development will result in some level of habitat loss locally, and may also result in a level of mortality at affected sites during construction, this will not result in any long-term effects on the local population. Mitigation measures will be implemented to ensure that the proposed road development will not affect water quality in the receiving environment during construction or affect the local groundwater regime.

Therefore, the proposed road development will not result in likely significant residual effects on mollusc species.

White-clawed crayfish and Freshwater pearl mussel are discussed in detail below with the receiving environment in **Section 8.3.8.1** and **8.3.8.2**; evaluation of impacts in **Section 8.5.7.1** and **8.5.7.2** and residual impacts in **Section 8.7.5.1** and **8.7.5.2**.

8.0.9 Marsh fritillary butterfly

The Marsh fritillary butterfly is listed on Annex II of the Habitats Directive. A local breeding population is present and is supported by suitable habitat patches across the western part of the study area, some of which are directly affected by the proposed road development.

Although the proposed road development will result in the loss of Marsh fritillary habitat, and will sever some habitat areas within their local range, and will likely cause a low level of mortality during operation, this will not result in any long-tern effects on the local population. However, the mortality risk during site clearance has the potential to have a significant effect on the local Marsh fritillary butterfly population. A mitigation strategy will be implemented to minimise this risk and avoid any population level effects.

Therefore, the proposed road development will not result in likely significant residual effects on the Marsh fritillary butterfly.

Marsh fritillary butterfly are discussed in detail below with the receiving environment in **Section 8.3.8.4**; evaluation of impacts in **Section 8.5.7.4**; proposed mitigation measures in **Section 8.6.8.2** and residual impacts in **Section 8.7.5.4**.

8.0.10 Breeding birds

A wide range of breeding bird species (62 in total) were recorded across the study area. These included species of conservation concern listed on the Amber and Red Birds of Conservation Concern in Ireland (BoCCI) lists, Annex I bird species, and species listed as SCIs for nearby SPA sites. All wild bird species are protected under the Wildlife Acts.

The proposed road development will result in the loss of breeding bird nesting and foraging habitat, it will pose a mortality risk to birds and it will disturb and potentially displace birds from breeding and foraging habitat. However, it will not result in any long-term effects on the majority of local breeding bird populations.

Barn owl are a breeding bird species of high conservation concern in Ireland and are particularly at risk of mortality from collisions with traffic. The nest site at Menlo Castle is in close proximity to the main construction works. Mitigation measures will be implemented to minimise the risk of impacts on Barn owl and to avoid any significant long-term residual impact on the local Barn owl population. These measures include the provision of additional nesting opportunities (nest boxes) and planting in high-risk areas to discourage Barn owl from foraging along the road edge and to encourage Barn owl to fly over the road carriageway above traffic height. The effectiveness of the mitigation measures will be monitored post-construction as part of the monitoring programme.

Although the Peregrine falcon nest site at Lackagh Quarry will be retained, it will be subject to high levels of disturbance during construction and operation. Mitigation measures will be implemented to minimise any disturbance effects (seasonal constraint during construction). However, there remains a risk that the Peregrine falcon will abandon Lackagh Quarry as a nesting site as a result of the proximity of the road carriageway to the existing nest site and due to the lack of suitable alternatives ledges in the quarry post-construction. This is likely to have long-term effects on the Peregrine falcon population at a local and county geographic scale.

Although the proposed road development is not likely to result in any significant residual effects on the majority of breeding bird species, there is likely to be a significant negative residual effect on Peregrine falcon at the county geographic scale.

Breeding birds are discussed in detail below with the receiving environment in **Section 8.3.9.1**; evaluation of impacts in **Section 8.4.8.1**; proposed mitigation measures in **Section 8.5.9.1**; residual impacts in **Section 8.6.6.1** and proposed compensation measures in **Section 8.8.3**.

8.0.11 Wintering birds

A wide range of wintering bird species were recorded across the study area. These included species of conservation concern listed on the Amber and Red BoCCI lists, Annex I bird species, and species listed as SCIs for nearby SPA sites. All wild bird species are protected under the Wildlife Acts.

The proposed road development will result in habitat loss across sites where wintering birds were recorded. It will result in some level of disturbance during operation and the proposed River Corrib Bridge poses a low level of collision risk to birds. However, it is not likely to result in any long-term effects on most local wintering bird populations. Ballindooley Lough, however, is an important local site for wintering birds – fourteen wintering bird species were recorded during the field surveys, including species listed as SCIs for Lough Corrib SPA and Inner Galway Bay SPA. Blasting in the vicinity of Ballindooley Lough during construction has the potential to displace wintering birds from this wetland habitat complex over multiple seasons. A seasonal restriction on blasting in this area will minimise the impact and avoid any long-term effects on wintering birds at Ballindooley Lough. Mitigation measures will also be implemented to ensure that the proposed road development will not affect water quality in the receiving environment during construction, or affect the local groundwater regime that supports wetland used by wintering birds.

Therefore, the proposed road development will not result in likely significant residual effects on wintering birds.

Wintering birds are discussed in detail below with the receiving environment in **Section 8.3.9.2**; evaluation of impacts in **Section 8.4.8.2**; proposed mitigation measures in **Section 8.5.9.2** and residual impacts in **Section 8.6.6.2**.

8.0.12 Amphibians

The Common frog and the Smooth newt are protected under the Wildlife Acts and were recorded in wetland habitats across the local area, including habitat impacted by the proposed road development.

Although the proposed road development will result in a temporary severance/barrier effect during construction, and present a mortality risk during operation, these impacts will not result in any long-term effects on the local population.

Mitigation measures will be implemented during construction to minimise the effects of habitat loss and disturbance to amphibians, to ensure that Common frog or Smooth newt are not killed during site clearance works, and to protect water quality in wetland habitat used by these species. During operation, the combination of the network of wildlife passage facilities, culverts, bridges and viaduct structures (e.g. the proposed River Corrib Bridge and the Menlough Viaduct) will reduce any long-term severance or barrier effects associated with the proposed road development such that the local amphibian populations will not be negatively affected.

Therefore, the proposed road development will not result in likely significant residual effects on amphibian species.

Amphibians are discussed in detail below with the receiving environment in **Section 8.3.10**; evaluation of impacts in **Section 8.4.9**; proposed mitigation measures in **Section 8.5.10** and residual impacts in **Section 8.6.7**.

8.0.13 Reptiles

Common lizard are protected under the Wildlife Acts and were recorded at Troscaigh Thiar, north of Bearna Woods and Knocknafroska/Knocknabrona during the field surveys.

Although the proposed road development will result in a temporary severance/barrier effect during construction, and present a mortality risk during operation, these impacts will not result in any long-term effects on the local population.

Mitigation measures will be implemented during construction to minimise the effects of habitat loss and disturbance on the local Common lizard population and to ensure that lizards are not killed during site clearance works. During operation, the combination of the network of wildlife passage facilities, culverts, bridges and viaduct structures (e.g. the proposed River Corrib Bridge and the Menlough Viaduct) will reduce any long-term severance or barrier effects associated with the proposed road development such that the local lizard populations will not be negatively affected.

Therefore, the proposed road development will not result in likely significant residual effects on the Common lizard.

Reptiles are discussed in detail below with the receiving environment in **Section 8.3.11**; evaluation of impacts in **Section 8.4.10**; proposed mitigation measures in **Section 8.5.11** and residual impacts in **Section 8.6.8**.

8.0.14 Fish

Fish species are protected under the Fisheries Acts, with Atlantic salmon, Brook lamprey and Sea lamprey also listed on Annex II of the Habitats Directive.

The proposed road development will result the loss of aquatic habitat, construction works may disturb fish species, and construction works may pose a temporary barrier to fish movement on minor watercourses. However, it will not result in any long-term effects on local fish populations. The drainage design will protect water quality in the receiving aquatic environment during operation. Mitigation measures will be implemented to ensure that the proposed road development will not affect water quality in the receiving environment during construction, affect the local groundwater regime, and minimise the risk of fish mortality during construction.

Therefore, the proposed road development will not result in likely significant residual effects on fish species.

8.0.15 Significant Residual Impacts

The significant residual impacts remaining after mitigation are those associated with habitat loss (see **Section 8.1.2**), impacts on bats (see **Section 8.1.5**) and impacts on Peregrine falcon (see **Section 8.1.10**). In relation to habitat loss, this includes three priority Annex I habitats (Petrifying springs, Residual alluvial forests and Limestone pavement), four Annex I habitat types (Wet heath, Dry heath, *Molinia* meadow and Calcareous grassland), in addition to five other non-Annex habitat types of a local biodiversity value.

Where possible, compensatory measures will be implemented to reduce or avoid these significant residual impacts. The loss of areas of the Annex I habitats Residual alluvial forests, Dry heath, *Molinia* meadows and Calcareous grassland will be compensated for, as will the loss of broadleaved woodland, hedgerows and treelines, and there will not be any significant residual impacts. The compensatory measures will reduce the residual impact significance on all bat species to a local level.

Despite the implementation of the mitigation and compensation measures proposed, the proposed road development will have the following likely significant residual effects on biodiversity:

- A likely significant residual effect, at the international geographic scale, for the permanent loss of c.0.54ha of the priority Annex I habitat Limestone pavement [*8240]
- A likely significant residual effect, at the national geographic scale, for the permanent loss of c.2.93ha of the Annex I habitat Wet heath [4010]
- A likely significant residual effect, at the county geographic scale, for the permanent loss of a Petrifying spring [*7220] feature at Lackagh Quarry
- A likely significant residual effect, at the county geographic scale, for the potential permanent loss of a Peregrine falcon nest site at Lackagh Quarry
- A likely significant residual effect, at the local geographic scale, on all bat species due to the presence of the proposed road development within their foraging areas
- A likely significant residual effect, at the local geographic scale, for the permanent loss of 15 calcareous springs (FP1) at Lackagh Quarry, c.7.81ha of Dry-humid acid grassland (GS3) and c.0.13ha of Poor fen and flush habitat (PF2).

These significant residual effects will also affect the following local biodiversity areas: Coast Road (R336) to the N59 Moycullen Road, the River Corrib and the Coolagh Lakes, Menlough to Coolough Hill, Ballindooley – Castlegar and the Doughiska area.

Although the significant residual effects associated with the losses of Limestone pavement and Wet heath habitat cannot be directly compensated for, areas of related habitats will be created to provide a biodiversity gain for both peatland and limestone associated habitats locally. The area of Dry heath habitat being provided is c.7.06ha which is greater than the combined losses of all peatland habitats (c.4.78ha). The area of Calcareous grassland habitat being provided is c.7.14ha which is greater than the combined losses of Limestone pavement and Calcareous grassland habitat (c.1.24ha).

8.1 Introduction

This chapter of the EIAR consists of an impact appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, under the heading of Biodiversity.

In accordance with the requirements of *Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment* (i.e. the EIA Directive), this chapter of the EIAR identifies, describes and assesses the likely direct and indirect significant effects of the proposed road development on biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC (i.e. the Habitats and Birds Directives). In addition, this chapter of the EIAR also identifies, describes and assesses the likely direct and indirect significant effects of the proposed road development on species protected pursuant to the Wildlife Acts 1976 to 2017.

The EIA Directive does not provide a definition of biodiversity. The Convention on Biological Diversity, however, gives a formal definition of biodiversity in its article 2: "biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Alongside the term “biodiversity” the terms “ecology” and “ecological” are also used throughout this chapter as a broader term to consider the relationships of biodiversity receptors to one another and to their environment.

The chapter is set out as follows:

- **Section 8.2** presents the methodology
- **Section 8.3** describes the existing environment
- **Section 8.4** summarises the main characteristics of the proposed road development which are of relevance for biodiversity
- **Section 8.5** evaluates the impacts of the proposed road development on biodiversity
- **Section 8.6** describes the measures proposed to mitigate these impacts
- **Section 8.7** describes the residual impacts
- **Section 8.8** describes the cumulative impacts

- **Section 8.9** describes the compensatory measures proposed to address the residual impacts
- **Section 8.10** presents a summary of the biodiversity chapter
- **Section 8.11** are the references quoted throughout the chapter

Table 8.1 below presents an outline of where the various groupings of ecological receptors are discussed in this chapter, for ease of reference.

Table 8.1: Ecological Receptors Presented within this Chapter

Ecological Receptor	Information Presented	Section Reference
Designated Areas for Nature Conservation	Receiving Environment	8.3.3
	Evaluation of Impacts	8.5.3
	Mitigation Measures	8.6.1
	Residual Impacts	8.7.1
	Compensation	n/a
Habitats	Receiving Environment	8.3.4
	Evaluation of Impacts	8.5.4
	Mitigation Measures	8.6.2-8.6.6
	Residual Impacts	8.7.2
	Compensation	8.9.1
Rare and protected plant species	Receiving Environment	8.3.5
	Evaluation of Impacts	8.5.5
	Mitigation Measures	n/a
	Residual Impacts	8.7.3
	Compensation	n/a
Non-native invasive plant species	Receiving Environment	8.3.6
	Evaluation of Impacts	n/a
	Mitigation Measures	n/a
	Residual Impacts	n/a
	Compensation	n/a
Otter	Receiving Environment	8.3.7.1
	Evaluation of Impacts	8.5.6.1
	Mitigation Measures	8.6.7.1
	Residual Impacts	8.7.4.1
	Compensation	n/a
Bats	Receiving Environment	8.3.7.2
	Evaluation of Impacts	8.5.6.2
	Mitigation Measures	8.6.7.2
	Residual Impacts	8.7.4.2

Ecological Receptor	Information Presented	Section Reference
	Compensation	8.9.2
Badgers	Receiving Environment	8.3.7.3
	Evaluation of Impacts	8.5.6.3
	Mitigation Measures	8.6.7.3
	Residual Impacts	8.7.4.3
	Compensation	n/a
Other Mammal Species	Receiving Environment	8.3.7.4
	Evaluation of Impacts	8.5.6.4
	Mitigation Measures	8.6.7.4
	Residual Impacts	8.7.4.4
	Compensation	n/a
White-clawed crayfish	Receiving Environment	8.3.8.1
	Evaluation of Impacts	8.5.7.1
	Mitigation Measures	n/a
	Residual Impacts	8.7.5.1
	Compensation	n/a
Freshwater pearl mussel	Receiving Environment	8.3.8.2
	Evaluation of Impacts	8.5.7.2
	Mitigation Measures	n/a
	Residual Impacts	8.7.5.2
	Compensation	n/a
Marsh whorl snail	Receiving Environment	8.3.8.3
	Evaluation of Impacts	8.5.7.3
	Mitigation Measures	8.6.8.1
	Residual Impacts	8.7.5.3
	Compensation	n/a
Marsh fritillary butterfly	Receiving Environment	8.3.8.4
	Evaluation of Impacts	8.5.7.4
	Mitigation Measures	8.6.8.2
	Residual Impacts	8.7.5.4
	Compensation	n/a
Breeding Birds	Receiving Environment	8.3.9.1
	Evaluation of Impacts	8.5.8.1
	Mitigation Measures	8.6.9.1
	Residual Impacts	8.7.6.1
	Compensation	8.9.3
Wintering Birds	Receiving Environment	8.3.9.2

Ecological Receptor	Information Presented	Section Reference
	Evaluation of Impacts	8.5.8.2
	Mitigation Measures	8.6.9.2
	Residual Impacts	8.7.6.2
	Compensation	n/a
Amphibians	Receiving Environment	8.3.10
	Evaluation of Impacts	8.5.9
	Mitigation Measures	8.6.10
	Residual Impacts	8.7.7
	Compensation	n/a
Reptiles	Receiving Environment	8.3.11
	Evaluation of Impacts	8.5.10
	Mitigation Measures	8.6.11
	Residual Impacts	8.7.8
	Compensation	n/a
Fish	Receiving Environment	8.3.12
	Evaluation of Impacts	8.5.11
	Mitigation Measures	8.6.12
	Residual Impacts	8.7.9
	Compensation	n/a

Along with surveys carried out specifically during the EIA phase of this project, this chapter has also utilised the information gathered during the constraints and route selection studies for the proposed road development to inform the biodiversity impact assessment. **Sections 4.3**, **6.5.1** and **7.6.1** of the **Route Selection Report** examined the biodiversity constraints within the scheme study area and compared the potential biodiversity impacts of the respective route corridors. These sections of the Route Selection Report contributed to the design of the proposed road development which this chapter assesses. **Chapter 5, Description of the Proposed Road Development** provides a detailed description of the proposed road development and **Chapter 7, Consturction Activies** outlines how it is proposed to construct the proposed road development.

8.2 Methodology

8.2.1 Introduction

The methodologies used to collate information on the baseline biodiversity environment and assess the potential impacts of the proposed road development are detailed in the following sections.

8.2.2 Legislation and Guidelines

The collation of ecological baseline data and the preparation of this chapter has had regard to the following legislation and guidance documents. This is not an exhaustive list of all legislation and guidelines but the most relevant legislative and guidelines basis for the purposes of preparing this EIAR.

Legislation:

- *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora*, hereafter referred to as the Habitats Directive
- *Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds*, hereafter referred to as the Birds Directive
- *European Communities (Birds and Natural Habitats) Regulations, 2011 (S.I. No. 477 of 2011)*, as amended, hereafter referred to as the Birds and Habitats Regulations
- *Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment, as amended by Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014*, hereafter referred to as the EIA Directive
- *Planning and Development Acts 2000 to 2017*, hereafter referred to as the Planning Acts[6]
- *Wildlife Acts 1976 to 2017*, hereafter referred to as the Wildlife Acts
- *Flora (Protection) Order, 2015 (S.I. No. 356 of 2015)*
- *Inland Fisheries Acts 1959 to 2017*, hereafter referred to as the Fisheries Acts.[7]

Guidance Documents:

- *Environmental Impact Assessment of Projects, Guidance on the preparation of the Environmental Impact Assessment Report* (European Commission, 2017)

[6] Updated to 2017 by virtue of Planning and Development (Amendment) Act 2017, s. 2(2).
[7] Updated to 2017 by virtue of Inland Fisheries (Amendment) Act 2017, s. 5(3).

- *Advice notes for Preparing Environmental Impact Statements* (Environmental Protection Agency, Draft September 2015)
- *Guidelines on the information to be contained in Environmental Impact Assessment Reports* (Environmental Protection Agency, Draft August 2017)
- *Guidelines on the Information to be contained in Environmental Impact Statements* (Environmental Protection Agency, 2002)
- *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements* (Environmental Protection Agency, 2003)
- *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment* (European Union, 2013)
- *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition* (CIEEM, 2016)
- Environmental Guidelines Series for Planning and Construction of National Roads *(*National Roads Authority, 2005-2009)
- *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (National Roads Authority, 2009)
- *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes* (National Roads Authority, 2008a) *Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edn)* (Collins, (ed.) 2016)
- *Environmental Impact Assessment of National Road Schemes – A Practical Guide* (National Roads Authority, 2008b)
- *The Bat Workers' Manual, 2nd Edition* (Mitchell-Jones & McLeish, 1999)
- *Bat Mitigation Guidelines for Ireland. Irish Wildlife Manuals, No. 25.* (Kelleher & Marnell, 2006)
- Design Manual for Roads and Bridges (Highways Agency 2001a, 2001b and 2005)
- *Circular NPW 1/10 & PSSP 2/10 Appropriate Assessment under Article 6 of the Habitats Directive: Guidance for Planning Authorities* (National Parks & Wildlife Service, 2010)
- *Circular Letter NPWS 2/07 Guidance on compliance with Regulation 23 of the Habitats Regulations 1997 – strict protection of certain species/applications for derogation licences* (National Parks & Wildlife Service, 2007a)
- *Circular Letter PD 2/07 and NPWS 1/07 Compliance Conditions in respect of Developments requiring (1) Environmental Impact Assessment (EIA); or (2) having potential impacts on Natura 2000 sites* (National Parks & Wildlife Service, 2007b)
- *Turloughs over 10 ha: vegetation survey and evaluation* (Goodwillie, R., 1992)
- *Turlough Hydrology, Ecology and Conservation* (Waldren, S. 2015, Ed.)
- *Summary of findings from the Survey of Potential Turloughs 2015* (O'Neill & Martin, 2015)

- *The Irish semi-natural grasslands survey 2007-2012. Irish Wildlife Manuals, No. 78* (O'Neill et al., 2013)
- *Results of monitoring survey of old sessile oak woods and alluvial forests. Irish Wildlife Manuals, No. 71* (O'Neill & Barron, 2013)
- *National survey of limestone pavement and associated habitats in Ireland. Irish Wildlife Manuals, No. 73* (Wilson & Fernández, 2013)
- *Coolagh Lakes, Lough Corrib SAC, Co. Galway: Wetland Survey and Conservation Assessment* (Crushell & Foss, 2014a: unpublished report)
- *Coolanillaun Bog, Lough Corrib SAC, Co. Galway: Wetland Survey and Conservation Assessment* (Crushell & Foss, 2014b: unpublished report)
- *Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. Irish Wildlife Manuals, No. 79* (Perrin et al., 2014)
- *Monitoring guidelines for the assessment of petrifying springs in Ireland. Irish Wildlife Manuals, No. 94* (Lyons & Kelly, 2016)

8.2.3 Data Sources and Consultations

A desktop study was carried out to inform the initial scope of the ecological surveys required to inform the environmental impact assessment. The desktop study involved collection and review of relevant published and unpublished sources of data, collation of existing information on the ecological environment and consultation with relevant statutory bodies.

8.2.3.1 Desk Study

The following sources were consulted during the desktop study to inform the scope of the ecological surveys:

- Online data available on Natura 2000 network of sites (hereafter referred to as European sites)[8] and on Natural Heritage Areas (NHAs) or proposed Natural Heritage Areas (pNHAs) as held by the National Parks and Wildlife Service (NPWS). Available online at <www.npws.ie/protectedsites/> and < http://webgis.npws.ie/npwsviewer/>. Accessed 06/09/2016 and 14/06/2017

[8] Article 3 of the Habitats Directive provides for the establishment of a coherent European ecological network of special areas of conservation, under the title Natura 2000. All Special Protection Areas for birds, as designated by legislation implementing the Birds Directive, are part of this Natura 2000 network. The aim of the network is to aid the long-term survival of Europe's most vulnerable and threatened species and habitats. In Ireland these sites are designated as "European sites" – defined under the Planning Acts and/or Birds and Habitats Regulations as (a) a candidate site of Community importance, (b) a site of Community importance, (c) a candidate special area of conservation, (d) a special area of conservation, (e) a candidate special protection area, or (f) a special protection area. They are commonly referred to in Ireland as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

- National Biodiversity Data Centre (NBDC) Online Database. Available online at <http://maps.biodiversityireland.ie/#/Map>. Accessed 19/02/2016 and 14/06/2017
- Ordnance Survey Ireland (OSI) orthophotography (from 1995 to 2012) for the scheme study area
- Records of rare and protected species for the 10km grid squares M22 and M32, held by the NPWS
- Habitat and species GIS datasets provided by the NPWS
- Bat records from Bat Conservation Ireland's (BCI) database
- N6 Galway City Outer Bypass. Environmental Impact Statement (RPS, 2006)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project Environmental Impact Statement (Galway County Council/Roscommon National Roads Design Office, 2011)
- Series of ecological reports carried out by RPS relating to the proposed R336 to N59 Road Scheme, Co. Galway (RPS, 2012a; RPS, 2012b; RPS, 2013a; RPS, 2013b; and, RPS, 2013c)
- Galway City Habitat Inventory. Galway City Council (Natura Environmental Consultants, 2005) – including digital mapping dataset
- Galway City Council Ardaun Local Area Plan Habitat Assessment (Natura Environmental Consultants, 2012)
- Coastal Habitat Study for Bearna (Galway County Council, 2007)
- *Pseudorchis albida* at Doughiska, Galway City – Report of a search in May-June 2005 (Roden, 2005)
- Galway Harbour Extension Environmental Impact Statement (Galway Harbour Company, 2014)
- The Barna Woods Project, Biodiversity Report (Browne et al., 2009)
- Results of the NBDC's 'Bioblitz' event (2014 & 2015) at the NUI Galway Campus
- The phytosociology and ecology of the aquatic and the wetland plant communities of the Lower Corrib Basin, Co. Galway. Proceedings of the Royal Irish Academy 90B (5) (Mooney & O'Connell, 1990)
- Various environmental planning reports relating to developments associated with NUI Galway (McCarthy, Keville & O'Sullivan, 2014a; McCarthy, Keville & O'Sullivan, 2014b; McCarthy, Keville & O'Sullivan, 2009a; McCarthy, Keville & O'Sullivan, 2009b; McCarthy, Keville & O'Sullivan, 2011; A.P. McCarthy Planning Consultants, 2007a and 2007b; and, Moore Group Environmental Services, 2011)
- The results of ecological surveys undertaken as part of the constraints and route selection studies (*N6 Galway City Transport Project: Route Selection Report* (Arup, 2016)4)

- The results of bird surveys carried out for the 2006 N6 Galway City Outer Bypass EIS (RPS, 2006)
- Environmental information/data for the area available from www.epa.ie (Envision Online Environmental Map Viewer - http://gis.epa.ie)
- Information on the status of EU protected habitats and species in Ireland (National Parks & Wildlife Service, 2013a, 2013b and 2013c)
- Water Framework Directive Fish Stock Survey of Lough Corrib, June 2014 (Kelly *et al.* 2014), and
- Corrib Estuary: Sampling Fish for the Water Framework Directive – Transitional Waters 2008 (The Central and regional Fisheries Board, 2009)

8.2.3.2 Consultations

The following organisations with relevance to ecology were consulted:

- The National Parks & Wildlife Service (NPWS) section of the Department of Culture, Heritage and the Gaeltacht (formerly the Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, and previous to that, the Department of Arts, Heritage and the Gaeltacht)
- Inland Fisheries Ireland (IFI)
- Bat Conservation Ireland (BCI)
- BirdWatch Ireland (BWI)
- Botanical Society of Britain & Ireland (BSBI)
- Kate McAney of the Vincent Wildlife Trust, and
- Other members of the public with local knowledge/records (e.g. relating to bat roosts).

A summary of consultations with the NPWS Section of the Department of Culture, Heritage and the Gaeltacht (formely Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs and previous to that Department of Arts, Heritage and the Gaeltacht)/NPWS and IFI is provided below. Species or plant records are included under the relevant headings in **Section 8.3 Receiving Environment**.

8.2.3.2.1 Department of Culture, Heritage and the Gaeltacht (NPWS)

Six meetings have been held with the NPWS: on 2 July 2014, 26 March 2015, 24 February 2016, 29 March 2017, 18 April 2017 and 03 August 2017. A formal consultation response related to the informal EIS Scoping Report was received from the Department of Arts, Heritage and the Gaeltacht on the 10 August 2016 and two documents related to the EIAR and NIS on the 16 and 18 January 2018 (Ref. G Pre00241/2016 – a copy of this is included in **Appendix A.8.2**). The NPWS made the following comments/observations relevant to the preparation of the EIAR and also provided notes on a draft of the EIA Biodiversity Chapter:

- The EIAR must address likely significant effects on European sites. The EIAR may align with and cross-reference or reflect content of the Natura Impact Statement but may not omit, overlook or exclude consideration of the likely effects on European sites. Issues which were raised by the NPWS specifically of relevance to Appropriate Assessment are listed separately in the Natura Impact Statement and are not repeated here
- The EIAR must assess likely significant effects on Natural Heritage Areas and proposed Natural Heritage Areas which are selected for certain ecological features and these should be used to inform the scope of the scientific assessment and analysis in the EIAR. It must also assess likely significant effects on non-statutory sites such as local biodiversity areas
- Existing guidance on EIA should be followed when preparing the EIAR, while also being cognisant of changes in interpretation and application of the EU Nature Directives and national legislation arising from case law. Terminology used should align with the legislation and case law, and in particular the specific tests of the assessment process
- The EIAR should consider key ecological receptors and should present data, information and analysis specific and relevant to the proposed road development, including characterisation of habitats as Annex I/Annex I priority habitat types (or not as the case may be) with scientific justification and supporting evidence (such as vegetation community data) to support conclusions reached. Botanic surveys should survey for presence of protected or rare species known from or potentially occurring within the locality (e.g. *Pseudorchis albida* and *Allium schoenoprasum*). Assessment of impacts on Annex I habitat types should assess the likely effects on habitat structure and function and should assess whether habitat loss could result in unfavourable or worsening national conservation status
- The EIAR must include a full and detailed description of all elements of the proposed road development
- The EIAR must assess potential cumulative impacts, in particular on existing and permitted proposed developments, along with the details of any mitigation measures that apply. The assessment of cumulative impacts should examine effects arising from existing or historic developments which may have resulted in impacts since the date from which EIA requirements existed
- Full details of mitigation measures should be provided and shown on maps. The likely effects of mitigation measures themselves should also be assessed and mitigated where necessary. Mitigation measures should be demonstrated to be effective in addressing the effects arising and should be demonstrated to be feasible within the specific characteristics and constraints of the proposed development site
- Appropriate specialist supervision should be proposed as necessary to ensure the correct implementation of mitigation measures at all stages of the proposed road development, including advance works contract stages

- The assessments in the EIAR should suffice to support any application for licences or derogations that may be necessary to disturb strictly protected or protected species and their breeding or resting places
- The NPWS are in the process of updating the digital mapping datasets into the ITM projection on modern OSI mapping. For European sites where this has not yet been completed, presenting the boundary of European sites on mapping included in the EIAR/NIS should be based upon an interpretation of its location relative to its intended location on the official 6” mapping (relative to the topographical features it follows on that mapping dataset).

These observations and comments have been taken on board and implemented throughout the EIAR.

8.2.3.2.2 Inland Fisheries Ireland (IFI)

Two meetings were held with IFI to discuss the fisheries value of watercourses crossed by the proposed road development: the first on 14 August 2014 and the second on 15 September 2016.

During these meetings, and in correspondence related to same, IFI made the following observations.

- Overall the area which the proposed road development falls within avoids the more sensitive and important areas for fisheries
- The River Corrib is a nationally important river system for Atlantic salmon. The Bearna Stream supports Sea trout and Atlantic salmon and this watercourse would be one of the main sites for these species in the locality, and other than the River Corrib is the most important stream affected by the proposed road development. IFI recently undertook improvement works to the Bearna Stream, particularly for Sea trout. The Sea trout spawning area in the Bearna Stream is downstream of the proposed road development. The Knocknacarra Stream supports Sea trout and the Newpark Stream (north of Tonabrocky) has trout spawning habitat. The Terryland River has poor habitat for salmonids and has been heavily drained in recent times as part of flood prevention measures. Electrofishing of this watercourse found little or no salmonids or eels present. The Terryland River does have Pike
- IFI had no records of spawning grounds for salmonids at any of the proposed watercourse crossing points along the proposed road development
- The banks of the River Corrib have lamprey spawning sites. IFI have observed Sea lamprey scaling the Salmon Weir and spawning in the upper catchment at Cong – this contradicts some published sources which state that the species was thought to be restricted below the Salmon Weir in Galway City
- Eels are present in good numbers in the River Corrib and may be present in other affected watercourses in smaller numbers. Eel passage has successfully been provided at Salmon Weir to facilitate migration since the 1950s. Any barriers to migration of eel would be of concern

- Ballindooley Lough does not support salmonids or lamprey but is used for coarse fishing (i.e. Perch, Roach, Bream and Pike). This waterbody is sensitive from an angling rather than ecological perspective in terms of fisheries
- Angling and navigation on the River Corrib is of importance. The Coolagh Lakes are not widely fished
- White-clawed Crayfish are present in Lough Corrib (there are small numbers in the Clare River north of the proposed road development) and could also be present in the River Corrib
- Bio-security protocols will be very important for the proposed road development. *Lagarosiphon major* and the Zebra Mussel are significant problems in the Corrib system. IFI guidelines on bio-security will need to be followed for both surveys for the EIAR and at construction stage for the proposed road development
- Japanese Knotweed and Himalayan Balsam are present on both the Terryland River and River Corrib
- IFI's long term aim is to improve the quality of streams and rivers. The proposed road development should not impede the achievement of this aim. The Sea trout population in watercourses along the western section of the proposed road development have collapsed and the long term aim is to restore the species in this area
- Stormwater discharges, in particular direct discharges to watercourses, are of concern. This should be addressed in both the design and construction methodology for the proposed road development
- Fish passage should be provided by burying culverts below bed level, ensuring flow levels are not increased, including bristles or baffles, with maintenance of same where necessary
- Habitat restoration/reinstatement following instream works will be required
- IFI have requested to be present on-site during construction and in particular for any stream diversions. Electrofishing may be required to move any captured fish downstream of construction works
- IFI have requested a detailed method statement from the contractor in advance of instream works
- Instream works will only be permitted between 1 July and end of September in accordance with IFI guidelines (IFI, 2016)
- Access to the River Corrib should be maintained on both the eastern and western banks at the River Corrib crossing location
- Section 50 approval has been granted by OPW for the proposed culverts. These culverts are box culverts with 300mm gravel in the stream bed
- The proposed systems for treatment of surface water from the proposed road development are noted by IFI to generally work well

8.2.4 Study Area and Baseline Data Collection

8.2.4.1 Study Area

The term "scheme study area", when used in this chapter, refers to the wider study area at which ecological constraints were initially identified for the constraints and route selection studies for the project (see **Figures 8.1.1** and **8.1.2**). This is the geographic scale at which many of the EIA level ecological surveys were initially carried out. For many of the ecological receptors, surveys were also carried out within a more restricted study area, focussed on assessing potential impacts within the Zone of Influence (ZoI)[9] of the proposed road development. **Section 8.2.4.2** below, describes the study area(s) for each ecological receptor and, where relevant, these study areas are also shown on the accompanying **Figures 8.1.1** to **8.22.1**.

8.2.4.2 Field Surveys

This section outlines the various ecological survey methodologies used to collate baseline ecological information in the preparation of this chapter. The surveys carried out are summarised below in **Table 8.2** with the full description of the survey methodologies presented in **Appendix A.8.1**.

The scoping exercise undertaken for the constraints and route selection studies for the project identified numerous sensitive ecological receptors within the scheme study area that could potentially have been impacted by the proposed road development. As a result, EIA level surveys for many of these ecological receptors were undertaken at the route selection stage of the project in order to inform the selection of the emerging preferred route corridor, as due to their ecological value they were highly likely to affect the ranking of route options. However, many of these surveys were carried out over a larger survey area (see also **Section 8.2.4.1**) and at a resolution appropriate to gathering information to inform the constraints and route selection studies, hence the requirement to carry out additional surveys for the EIA stage of the project in subsequent seasons/years to supplement the information already gathered and fill any gaps, spatially, in the ecological baseline datasets. Under each section below, where different surveys relating to a particular ecological receptor (e.g. habitats) were undertaken over a number of survey seasons or covering different geographic locations along the route of the proposed road development, each of the surveys undertaken are described in chronological order.

[9] The 'zone of influence' for a development is the area over which ecological features may be subject to significant impacts as a result of the proposed development and associated activities (CIEEM, 2016) – see Section 8.3.1 for more detail on the ZoI as it relates to the proposed road development.

Table 8.2: Ecological Surveys and Survey Dates between 2013 and 2018

Survey	Survey Date(s)	Surveyor(s)
Habitat surveys[10]: • Lough Corrib cSAC – Selected Locations (RS) • Petrifying springs survey (RS) • Lough Corrib candidate Special Area of Conservation (cSAC) Study Area (RS) • Ecological Sites [11] (RS) • Aquatic habitats (RS) • Lackagh Quarry Petrifying spring survey (EIA) • EIA Habitat surveys (EIA)	July to September 2013 March to June 2014 May to September 2014 June to October, 2014 June to September, 2014 June 2015 September to December 2015 July to October 2016 May 2017 to January 2018	Botanical, Environmental & Conservation (BEC) Consultants Ltd., Scott Cawley Ltd. and various independent botanists including Dr Joanne Denyer, Dr John Conaghan, Dr Janice Fuller, Katharine Duff. Eamon O'Sullivan, Roger Goodwillie, Dr Cilian Roden, Michelle O'Neill and Mary O'Connor.
Protected plant species: • Slender naiad *Najas flexilis* (RS) • Varnished hook-moss *Hamatocaulis vernicosus* (RS)	June to September, 2014 September 2014	Dr Cilian Roden Dr Rory Hodd
Otter survey (River Corrib and Coolagh Lakes) (RS)	April and May 2014	Scott Cawley Ltd.
Mammal survey (excluding bats)	April to June and October/November 2015 October 2016 October/November 2017	Scott Cawley Ltd. and Dr Chris Peppiatt
Bat surveys: Winter hibernation surveys (RS and EIA) Building surveys (RS and EIA)	March 2014 & February 2015 & 2016, January 2018 July to October 2014 August /September 2015 July/August 2016	Scott Cawley Ltd., Greena Ecological Consultancy Ltd., Geckoella Ltd. and independent bat specialists including Conor Kelleher, Brian

[10] Some ecological surveys were carried out during the constraints and route selection studies of the project in 2014 and were carried out at a different spatial scale and without reference to any ZoI as it would relate to study area for the route of the proposed road development. These surveys later informed the EIA ecological surveys and for ease of reference are denoted with RS in parenthesis in **Table 8.2**. Those surveys carried out specific to the EIA assessment of the proposed road development and its ZoI are denoted with EIA in parenthesis.

[11] Ecological Sites, in this case, are sites of potential ecological value for the habitats present: i.e. determined to be at least of a Local Importance (higher value) (refer to National Roads Authority, 2009 for more detail). The boundaries of the Ecological Sites were initially defined based on interpretation of orthophotography and collation of available existing habitat information, in conjunction with a ground truthing exercise to verify the orthophotography interpretation. These boundaries were then refined, where appropriate, based on the findings of the various habitat surveys undertaken.

Survey	Survey Date(s)	Surveyor(s)
Tree surveys (EIA)	June/July 2017 August 2018 April to November 2015	Keeley, Isobel Abbott, Barbara McInerney, Caroline Shiel and Barry Ryan
Vehicle transect surveys (RS) Walked transect surveys (RS) Static detector activity surveys from 2014 to 2018 (RS and EIA) Radio-tracking studies (three studies in 2014, one study in 2015) (RS and EIA) Marking studies (RS and EIA)	June/July 2014 June/July 2014 August to November 2014 July to October 2015 July to August 2017 May 2018 July/August 2014 August 2014 September 2014 May 2015 July 2014 to August 2016	
White-clawed crayfish survey (RS)	September, 2014	Scott Cawley Ltd. and Dr Julian Reynolds
Molluscan surveys (includes Freshwater pearl mussel and *Vertigo* snail species surveys) (RS)	August 2014 October 2017 (two additional molluscan sites)	Dr Evelyn Moorkens and Dr Ian Killeen
Marsh fritillary surveys (RS and EIA)	September 2013 September/October 2014 September 2015 September 2016	Woodrow Environmental Consultants Ltd.
Red grouse survey (RS)	June to August, 2014	Dr Chris Peppiatt
Barn owl survey (RS and EIA)	June and July 2014 July 2015 June and July, 2016 May to September 2018	BirdWatch Ireland
Peregrine falcon survey (EIA)	June and July 2016 May to September 2018	BirdWatch Ireland
Breeding bird surveys (EIA)	May and June 2015 June 2016	Dr Chris Peppiatt, Gerry Murphy, John Small
Woodcock survey (EIA)	May/June 2015 & June 2016	Dr Chris Peppiatt
Wintering bird survey (RS)	September 2014 to March, 2015	Scott Cawley Ltd., Dr Chris Peppiatt, Gerry Murphy, John Small and Tom Cuffe.
Amphibian survey (EIA)	April to June 2015 June 2016	Scott Cawley Ltd. and Dr Chris Peppiatt
Reptile survey (EIA)	September/October 2015	Scott Cawley Ltd.
Fisheries surveys (including assessment of biological water quality status) (EIA)	September 2015	Triturus Environmental Services Ltd.

8.2.5 Impact Assessment Methodology

The biodiversity and ecological impacts of the proposed road development have been assessed using the following guidelines:

- *Environmental Impact Assessment of Projects, Guidance on the preparation of the Environmental Impact Assessment Report* (European Commission, 2017)
- *Guidelines on the Information to be contained in Environmental Impact Statements* (Environmental Protection Agency, 2002)
- *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements* (Environmental Protection Agency, 2003)
- *Guidelines on the information to be contained in Environmental Impact Assessment Reports* (Environmental Protection Agency, Draft August 2017)
- *Advice notes for Preparing Environmental Impact Statements* (Environmental Protection Agency, Draft September 2015)
- *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition* (CIEEM, 2016)
- *Guidelines for assessment of Ecological Impacts of National Road Schemes* (National Roads Authority, 2009)

Valuing the Ecological Receptors

Biodiversity receptors (including identified sites of biodiversity importance) have been valued with regard to the ecological valuation examples set out in the TII guidelines (National Roads Authority, 2009).

All Annex I habitats that lie outside of European sites, are valued as being of national importance, given that these habitats are of high conservation concern. However, priority Annex I habitat types are valued as being of international importance given that they are of the highest conservation concern at a European level (i.e. natural habitat types in danger of disappearance[12]).

Habitat areas within SACs are considered in the context of assessing impacts on the conservation objectives and site integrity of a given European site with regard to the Appropriate Assessment tests set out in Article 6(3) of the Habitats Directive. All European sites are valued as internationally important.

In accordance with TII guidelines (National Roads Authority, 2009), biodiversity features within the Zone of Influence (ZoI) of the proposed road development which are "both of sufficient value to be material in decision making and likely to be affected significantly" are deemed to be 'Key Ecological Receptors' (KERs). These are the biodiversity receptors which may be subject to likely significant effects from the proposed road development, either directly or indirectly. KERs are those biodiversity receptors with an ecological value of local importance (higher value) or greater.

Characterising and Describing the Impacts

[12] From the definition of "priority natural habitat types" in Article 1(d) of the Habitats Directive

The parameters considered in characterising and describing the magnitude or scale of the potential impacts of the proposed road development are outlined in **Table 8.3** below.

Table 8.3: Parameters used to characterise and describe the magnitude or scale of potential impacts

Parameter	Categories
Type of impact	Positive/Neutral/Negative May also include Cumulative Effects, 'Do Nothing Effects', 'Do Minimum Effects', Indeterminable Effects, Irreversible Effects, Residual Effects, Synergistic Effects, Indirect Effects and/or Secondary Effects
Extent	The size of the affected area/habitat and/or the proportion of a population affected by the effect
Duration	The period of time over which the effect will occur[13].
Frequency and Timing	How often the effect will occur; particularly in the context of relevant life-stages or seasons
Reversibility	Permanent/Temporary Will an impact reverse; either spontaneously or as a result of a specific action

The likelihood of an impact occurring, and the predicted effects, are also an important consideration in characterising impacts. The likelihood of an impact occurring is assessed as being certain, likely or unlikely; in some cases it may be possible to definitively conclude that an impact will not occur.

Professional judgement is used in considering the contribution of all relevant criteria in determining the overall magnitude of an impact.

Impact Significance

In determining impact significance, the NRA (2009) and CIEEM (2016) guidelines were followed, which requires examination of the following two key elements:

- Impact on the integrity of the ecological feature
- Impact on its conservation status within a given geographical area

Integrity

The term "integrity" should be regarded as the coherence of ecological structure and function, across the entirety of a site that enables it to sustain all of the biodiversity or ecological resources for which it has been valued (National Roads Authority, 2009).

The term 'integrity' is most often used when determining impact significance in relation to designated areas for nature conservation (e.g. SACs, SPAs or pNHA/NHAs) but can often be the most appropriate method to use for non-

[13] The following terms/definitions for describing the duration of impacts are provided in the Environmental Protection Agency guidelines (Draft August 2017): Momentary Effects - effects lasting from seconds to minutes; Brief Effects - effects lasting less than a day; Temporary Effects - effects lasting less than a year; Short-term Effects - effects lasting one to seven years; Medium-term Effects - effects lasting seven to fifteen years; Long-term Effects - effects lasting fifteen to sixty years; Permanent Effects - effects lasting over sixty years.

designated areas of biodiversity value where the component habitats and/or species exist with a defined ecosystem at a given geographic scale.

An impact on the integrity of an ecological site or ecosystem is considered to be significant if it moves the condition of the ecosystem away from a favourable condition: removing or changing the processes that support the sites' habitats and/or species; affect the nature, extent, structure and functioning of component habitats; and/or, affect the population size and viability of component species.

Conservation Status

The definitions for conservation status given in the EU Habitats Directive 92/43/EEC, in relation to habitats and species, are also used in the CIEEM (2016) and NRA (2009) guidance:

- For natural habitats, conservation status means the sum of the influences acting on the natural habitat and its typical species, that may affect its long-term distribution, structure and functions as well as the long-term survival of its typical species, at the appropriate geographical scale
- For species, conservation status means the sum of influences acting on the species concerned that may affect the long-term distribution and abundance of its populations, at the appropriate geographical scale

An impact on the conservation status of a habitat or species is considered to be significant if it will result in a change in conservation status.

After the definitions provided in the EU Habitats Directive 92/43/EEC, the conservation status of a habitat is favourable when:

- Its natural range and areas it covers within that range are stable or increasing
- The specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future
- The conservation status of its typical species is favourable as defined below under species

And, the conservation status of a species is favourable when:

- Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future
- There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis

According to the TII/CIEEM methodology, if it is determined that the integrity and/or conservation status of an ecological feature will be impacted on, then the level of significance of that impact is related to the geographical scale at which the impact will occur (i.e. local, county, national, international). In some cases an impact may not be significant at the geographic scale at which the ecological feature has been valued but may be significant at a lower geographical level. For example, a particular impact may not be considered likely to have a negative effect on the overall conservation status of a species which is considered to be internationally important. However, an impact may occur at a local level on this internationally important species. In this case, the impact on an internationally important species is considered to be significant at only a local, rather than international level.

8.3 Receiving Environment

The following section describes the receiving ecological environment and biodiversity within the Zone of Influence (ZoI) of the proposed road development.

The proposed road development extends around the north of Galway City from the Coast Road (R336), west of Bearna, to the existing N6 at Coolagh, Briarhill. There are four significant structures included in the design of the proposed road development, namely the River Corrib Bridge, Menlough Viaduct, Lackagh Tunnel and Galway Racecourse Tunnel. A full description of the proposed road development is presented in **Chapter 5, Description of the Proposed Road Development**.

The nature of the local receiving environment is heavily influenced by the underlying geology. Lands to the west of the N59 Moycullen Road are underlain by granite and are characterised by a mosaic of peatland habitats set amongst the local road network and associated linear residential development. This area slopes towards Galway Bay to the south and is drained by a network of small streams including Sruthán na Líbeirtí, the Trusky Stream, the Bearna Stream, the Tonabrocky Stream and the Knocknacarra Stream. Lands to the east of the N59 Moycullen Road are underlain by limestone which gives rise to a karst landscape. The NUIG Sporting Campus lie on the western side of the River Corrib. Moving east from the River Corrib the landscape is characterised by a mosaic of semi-natural woodland, scrub and exposed limestone rock as far as Lackagh Quarry. East of here, these habitats exist in more isolated patches amongst the improved agricultural fields and industrial/commercial developments that fringe the eastern edge of Galway City. In the eastern part of the study area the River Corrib (and it's tributary the Terryland River) are the only watercourses present. There are two wetland complexes associated with freshwater lake systems, Coolagh Lakes and Ballindooley Lough, both of which are influenced by the underlying karst groundwater regime.

Section 8.3.1 establishes the ZoI of the proposed road development. **Section 8.3.2** summarises the results of the desk study and consultations undertaken in the preparation of this chapter. **Section 8.3.4** to **Section 8.3.13** describe the ecological baseline as it relates to the ecological receptors recorded, or known from, the study area under the following headings: habitats, rare and protected plant species, non-native invasive plant species, mammals (excluding bats), bats, invertebrate species, bird species, amphibian species, reptiles and fish. **Section 8.3.14** provides a summary of the ecological valuation of each ecological receptor potentially affected by the proposed road development and identifies those which are Key Ecological receptors (KERs) and subject to impact assessment.

8.3.1 Zone of Influence

The Zone of Influence (ZoI), or distance over which a likely significant effect may occur will differ across the Key Ecological Receptors, depending on the potential impact pathway(s). The results of both the desk study and the suite of ecological field surveys undertaken has established the habitats and species present along the proposed road development. The ZoI is then informed and defined by the sensitivities of each of the ecological receptors present, in conjunction with the nature and potential impacts associated with the proposed road development.

The ZoI of the proposed road development in relation to terrestrial habitats is generally limited to the footprint of the proposed road development, and the immediate environs (to take account of shading or other indirect impacts, such as air quality). Hydrogeological/hydrological linkages (e.g. rivers or groundwater flows) between impact sources and wetland/aquatic habitats can often result in impacts occurring at significant distances. The unmitigated hydrogeological ZoI for the proposed road development is shown on **Figure 10.7.1** to **10.7.14** and **10.9.1** to **10.9.14**. In the western part of the study area, it generally follows the proposed development boundary plus a buffer of up to c.30m in places. East of the N59 Moycullen Road, the ZoI is more expansive, given the underlying karst geology and the potential for groundwater impacts within those groundwater bodies traversed by the proposed road development.

With regard to hydrological impacts, the distances over which water-borne pollutants are likely to remain in sufficient concentrations to have a likely significant effect on receiving waters and associated wetland/terrestrial habitats is difficult to quantify and highly site-specific and related to the predicted magnitude of any potential pollution event. Evidently, it will depend on volumes of discharged waters, concentrations and types of pollutants (in this case sediment, hydrocarbons, and heavy metals), volumes of receiving waters, and the sensitivity of the ecology of the receiving waters. In the case of the proposed road development, this includes all freshwater habitat downstream of the proposed watercourse crossings and Galway Bay.

The ZoI of air quality effects is generally local to the proposed road edge and not greater than a distance of 200m.

The ZoI for small mammal species, such as the Pygmy Shrew, would be expected to be limited to no more than 100m from the proposed development boundary due to their small territory sizes and sedentary lifecycle. The ZoI for Otters, Badgers, Stoat, and Hedgehogs may extend over greater distances than small mammal and bird species due to their ability to disperse many kilometres from their natal site. The ZoI of impacts for significant disturbance impacts to Badger and Otter breeding/resting places is 150m from the proposed development boundary.

The ZoI of potential impacts to bat roosts would not be expected to exceed 200m in most cases but as affects are dependent on many factors (such as species, roost type, surrounding habitat, commuting routes etc.), this is assessed on a case by case basis and the ZoI may increase/decrease from this distance accordingly. Given the large foraging ranges for some species[14], the ZoI of potential landscape scale impacts, such as habitat loss and severance, could extend for several kilometres from the proposed road development but the most significant effects are likely to occur within 1km of important roost sites (e.g. maternity roosts).

The ZoI of the proposed road development in relation to likely significant effects on most breeding bird species is generally limited to habitat loss within the footprint of the proposed road development, and disturbance/displacement during construction and disruption in territorial singing due to noise during operation. Disturbance effects may extend for several hundred metres from the proposed road development.

The ZoI in relation to direct impacts to wintering birds could extend up to 300m from the proposed road development for general construction activities, and as far as 800m where prolonged blasting will be carried out, as many species are highly susceptible to disturbance from loud and unpredictable noise during construction. However, as many estuarine bird species use inland habitat areas at distances from the coast, the ZoI for ex-situ impacts could extend a considerable distance from the proposed road development. In the case of the proposed road development, impacts to wintering birds within this 300m band could affect the use of potential ex-situ sites for bird species listed as Special Conservation Interests of the nearby Lough Corrib SPA and Inner Galway Bay SPA.

The ZoI in relation to amphibian species is likely to be limited to direct habitat loss with the proposed development boundary and/or indirect impacts to water quality in wetland habitats hydrologically connected to the proposed road development.

The ZoI in relation to the Common lizard is likely to be limited to direct habitat loss with the proposed development boundary and disturbance/displacement effects in the immediate vicinity during construction.

The ZoI for impacts to aquatic species, such as Atlantic salmon and lamprey species, is limited to those watercourses crossed by the proposed road development or waterbodies to which runoff from the proposed road development could drain to during construction (i.e. Coolagh Lakes). However, impacts could occur at significant distances downstream depending on the magnitude and duration of any pollution event; potentially even affecting species in Galway Bay.

The ecological ZoI of the proposed road development is shown on **Figure 8.12.1** and **Figure 8.13.1**.

8.3.2 Desk Study

The results of the desktop review are provided in **Appendix A.8.18** and are incorporated into the sections below under the relevant headings, as relevant. Additional discussion on local biodiversity areas from the draft *Galway City Biodiversity Action Plan 2014-2024* is also provided below.

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[14] Leisler's bats have been recorded foraging up to 13km from maternity roost sites (Shiel et al., 1999)

8.3.2.1 Local Biodiversity Areas

The *Galway City Development Plan 2017–2023* and the most recent draft of the *Galway City Biodiversity Action Plan 2014–2024* include reference to a local network of biodiversity areas in the city. These areas are derived from sites identified in the *Galway City Habitats Inventory* (Natura, 2005) and were defined based upon habitat areas of high biodiversity value.

Some of these local biodiversity areas lie within the zone of influence of the proposed road development and, where relevant, the habitats present within these areas are discussed further below in **Section 8.3.4** and the potential impacts assessed in **Section 8.5.4**. The relevant local biodiversity areas are:

- Rusheen Bay – Barna Woods – Illaunafamona
- Cappagh – Ballymoneen
- Ballagh – Barnacranny Hill
- River Corrib and adjoining wetlands
- Menlough to Coolough Hill
- Ballindooley – Castlegar (which is linked to the River Corrib by the Terryland River)
- Galway Racecourse, Ballybrit
- Doughiska
- Mutton Island and nearby shoreline

Local biodiversity areas provide habitat for a range of species with the River Corrib corridor providing an important link between Galway Bay and the mosaic of habitats surrounding the city, which includes the wetland complex associated with Lough Corrib. Important fauna species noted in the most recent draft of the *Galway City Biodiversity Action Plan 2014–2024* include Pine marten *Martes martes*, Wood mouse *Apodemus sylvaticus*, Irish stoat *Mustela erminea hibernica*, Irish hare *Lepus timidus hibernicus*, Hedgehog *Erinaceus europaeus*, Pygmy shrew *Sorex minutus*, Harbour seal *Phoca* vitulina, Fox *Vulpes vulpes*, Bank vole *Myodes glareolus,* Otter *Lutra lutra*, Badger *Meles meles,* Lesser horseshoe bat *Rhinolophus hipposideros*, Leisler's bat *Nyctalus leisleri*, Common pipistrelle bat *Pipistrellus pipistrellus*, Soprano pipistrelle bat *Pipistrellus pygmaeus*, Brown long-eared bat *Plecotus auritus*, Daubenton's bat *Myotis daubentonii*, Natterer's bat *Myotis nattereri* and the Whiskered bat *Myotis mystacinus*. These species are discussed further below in **Section 8.3.7** and the potential impacts assessed in **Section 8.5.6**. The Flora (Protection) Order, 2015 listed species Slender cottongrass *Eriophorum gracile* and the Small white orchid *Pseudorchis albida* are also noted in the plan and are discussed further below in **Section 8.3.5** and the potential impacts assessed in **Section 8.5.5**.

8.3.3 Designated Areas for Nature Conservation

8.3.3.1 European Sites

Candidate Special Areas of Conservation (cSAC) are designated under the EC Habitats Directive (92/43/EEC) as amended, which is transposed into Irish law through a variety of legislation including the Birds and Habitats Regulations and the Planning Acts, for the protection of habitats listed on Annex I and/or species listed on Annex II of the Directive.

Special Protection Areas (SPAs) are designated under the Birds Directive (2009/147/EC) for the protection of protected bird species listed on Annex I of the Directive, regularly occurring populations of migratory species (such as ducks, geese or waders), and areas of international importance for migratory birds.

The proposed road development traverses through, and adjacent to, the Lough Corrib cSAC and there are three other European sites nearby (Lough Corrib SPA is upstream of the proposed road development and Galway Bay Complex cSAC, and Inner Galway Bay SPA are downstream) with a number of other European sites located at a greater distance from the proposed development boundary. There are 19 European sites (cSACs or SPAs) located within 15km[15] of the proposed development boundary (**Figure 8.12.1**) which encompasses all European sites within the ZoI of the proposed road development. **Table 8.4** below lists these sites, their distance from the proposed development boundary, and the sites Qualifying Interests/Special Conservation Interests.

Table 8.4: European Sites (cSACs and SPAs) within 15km of the proposed development boundary

Site Name	Distance[16]	Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)
Candidate Special Areas of Conservation		
Lough Corrib cSAC [000297]	crossed by the proposed road develop-ment	[1029] Freshwater pearl mussel *Margaritifera margaritifera* [1092] White-clawed crayfish *Austropotamobius pallipes* [1095] Sea lamprey *Petromyzon marinus* [1096] Brook lamprey *Lampetra planeri* [1106] Atlantic salmon *Salmo salar* (only in fresh water) [1303] Lesser horseshoe bat *Rhinolophus hipposideros* [1355] Otter *Lutra lutra* [1393] Varnished hook-moss *Drepanocladus (Hamatocaulis) vernicosus* [1833] Slender naiad *Najas flexilis* [3110] Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*)

[15] 15km used as an itial reference scale only and did not inform the definition of the ZoI nor did it influence the identification of designated sites at risk from potential impacts associated with the proposed road development
[16] Distance in km/m from the proposed road development

Site Name	Distance[16]	Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)
		[3130] Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea* [3140] Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3260] Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*) (*important orchid sites) [6410] *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) [7110] * Active raised bogs [7120] Degraded raised bogs still capable of natural regeneration [7150] Depressions on peat substrates of the *Rhynchosporion* [7210] * Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* [7220] * Petrifying springs with tufa formation (*Cratoneurion*) [7230] Alkaline fens [8240] * Limestone pavements [91A0] Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles [91D0] * Bog woodland
Galway Bay Complex cSAC [000268][17]	160m	[1140] Mudflats and sandflats not covered by seawater at low tide [1150] Coastal lagoons* [1160] Large shallow inlets and bays [1170] Reefs [1220] Perennial vegetation of stony banks [1310] *Salicornia* and other annuals colonising mud and sand [1330] Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1355] Otter *Lutra lutra* [1365] Harbour seal *Phoca vitulina* [1410] Mediterranean salt meadows (*Juncetalia maritimi*) [3180] Turloughs* [5130] *Juniperus communis* formations on heaths or calcareous grasslands

[17] Inner Galway Bay is also a Ramsar site, under the Ramsar Convention (Ramsar site No. 838) and is a marine protected site under the OSPAR Convention - Galway Bay Complex MPA (O-IE-0002969)

Site Name	Distance[16]	Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)
		[6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*) (*important orchid sites) [7210] Calcareous fens with *Cladium mariscus* and species of the Caricion davallianae* [7230] Alkaline fens
Connemara Bog Complex cSAC [002034]	6km	[1065] Marsh fritillary butterfly *Euphydryas* (*Eurodryas, Hypodryas*) *aurinia* [1106] Atlantic salmon *Salmo salar* (only in fresh water) [1150] * Coastal lagoons [1170] Reefs [1355] Otter *Lutra lutra* [1833] Slender naiad *Najas flexilis* [3110] Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*) [3160] Natural dystrophic lakes and ponds [3260] Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [4010] Northern Atlantic wet heaths with *Erica tetralix* [4030] European dry heaths [6410] *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) [7130] Blanket bogs (* if active only) [7140] Transition mires and quaking bogs [7150] Depressions on peat substrates of the *Rhynchosporion* [7230] Alkaline fens [91A0] Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles
Ross Lake and Woods cSAC [001312]	10.2km	[1303] Lesser horseshoe bat *Rhinolophus hipposideros* [3140] Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
Black Head-Poulsallagh Complex cSAC [000020]	10.6km	[1170] Reefs [1220] Perennial vegetation of stony banks [1395] Petalwort *Petalophyllum ralfsii* [3260] Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [4060] Alpine and Boreal heaths [5130] *Juniperus communis* formations on heaths or calcareous grasslands [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*) (*important orchid sites)

Site Name	Distance[16]	Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)
		[6510] Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) [7220] Petrifying springs with tufa formation (*Cratoneurion*) [8240] Limestone pavements [8330] Submerged or partially submerged sea caves
Lough Fingall Complex cSAC [000606]	11.1km	[1303] Lesser horseshoe bat *Rhinolophus hipposideros* [3180] * Turloughs [4060] Alpine and Boreal heaths [5130] *Juniperus communis* formations on heaths or calcareous grasslands [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*) (* important orchid sites) [7210] * Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* [8240] * Limestone pavements
Rahasane Turlough SAC [000322]	13.2km	[3180] * Turloughs
Gortnandarragh Limestone Pavement cSAC [001271]	13.4km	[8240] * Limestone pavements
Moneen Mountain cSAC [000054]	13.2km	[1065] Marsh fritillary butterfly *Euphydryas* (*Eurodryas*, *Hypodryas*) *aurinia* [1303] Lesser horseshoe bat *Rhinolophus hipposideros* [3180] * Turloughs [4060] Alpine and Boreal heaths [5130] *Juniperus communis* formations on heaths or calcareous grasslands [6130] Calaminarian grasslands of the *Violetalia calaminariae* [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*) (*important orchid sites) [7220] * Petrifying springs with tufa formation (*Cratoneurion*) [8240] * Limestone pavements
East Burren Complex cSAC [001926]	13.5km	[1065] Marsh fritillary butterfly *Euphydryas* (*Eurodryas, Hypodryas*) *aurinia* [1303] Lesser horseshoe bat *Rhinolophus hipposideros* [1355] Otter *Lutra lutra* [3140] Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3180] * Turloughs

Site Name	Distance[16]	Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)
		[3260] Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [4060] Alpine and Boreal heaths [5130] *Juniperus communis* formations on heaths or calcareous grasslands [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites) [6510] Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) [7210] * Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* [7220] * Petrifying springs with tufa formation (*Cratoneurion*) [7230] Alkaline fens [8240] * Limestone pavements [8310] Caves not open to the public [91E0] * Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*)
Kiltiernan Turlough cSAC [001285]	13.8km	[3180] * Turloughs
Castletaylor Complex cSAC [000242]	14km	[3180] * Turloughs [4060] Alpine and Boreal heaths [5130] *Juniperus communis* formations on heaths or calcareous grasslands [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites) [8240] * Limestone pavements
Ardrahan Grassland cSAC [002244]	15km	[4060] Alpine and Boreal heaths [5130] *Juniperus communis* formations on heaths or calcareous grasslands [8240] * Limestone pavements
Ballyvaughan Turlough cSAC [000996]	15km	[3180] * Turloughs
Special Protection Areas		
Lough Corrib SPA [004042]	203m	Greenland White-fronted Goose (*Anser albifrons flavirostris*) [A395] - wintering Gadwall (*Anas strepera*) [A051] - wintering Shoveler (*Anas clypeata*) [A056] - wintering Pochard (*Aythya ferina*) [A059] - wintering Tufted Duck (*Aythya fuligula*) [A061] - wintering

Site Name	**Distance[16]**	**Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)**
		Common Scoter (*Melanitta nigra*) [A065] - breeding Hen Harrier (*Circus cyaneus*) [A082] – post-breeding/roost Coot (*Fulica atra*) [A125] - wintering Golden Plover (*Pluvialis apricaria*) [A140] - wintering Black-headed Gull (*Chroicocephalus ridibundus*) [A179] - breeding Common Gull (*Larus canus*) [A182] - breeding Common Tern (*Sterna hirundo*) [A193] - breeding Arctic Tern (*Sterna paradisaea*) [A194] – breeding Wetlands & Waterbirds [A999]
Inner Galway Bay SPA [004031]	1.1km at Oranmore Bay and Rusheen Bay	Great Northern Diver (*Gavia immer*) [A003] - wintering Cormorant (*Phalacrocorax carbo*) [A017] - breeding Grey Heron (*Ardea cinerea*) [A028] - wintering Light-bellied Brent Goose (*Branta bernicla hrota*) [A046] - wintering Wigeon (*Anas penelope*) [A050] - wintering Teal (*Anas crecca*) [A052] - wintering Shoveler (*Anas clypeata*) [A056] - wintering Red-breasted Merganser (*Mergus serrator*) [A069] - wintering Ringed Plover (*Charadrius hiaticula*) [A137] - wintering Golden Plover (*Pluvialis apricaria*) [A140] - wintering Lapwing (*Vanellus vanellus*) [A142] - wintering Dunlin (*Calidris alpina*) [A149] - wintering Bar-tailed Godwit (*Limosa lapponica*) [A157] - wintering Curlew (*Numenius arquata*) [A160] - wintering Redshank (*Tringa totanus*) [A162] - wintering Turnstone (*Arenaria interpres*) [A169] - wintering Black-headed Gull (*Chroicocephalus ridibundus*) [A179] - wintering Common Gull (*Larus canus*) [A182] - wintering Sandwich Tern (*Sterna sandvicensis*) [A191] - breeding Common Tern (*Sterna hirundo*) [A193] - breeding Wetlands & Waterbirds [A999]
Cregganna Marsh SPA [004142]	4km	Greenland White-fronted Goose (*Anser albifrons flavirostris*) [A395] - wintering
Connemara Bog Complex SPA [004181]	9.2km	Cormorant (*Phalacrocorax carbo*) [A017] - breeding Merlin (*Falco columbarius*) [A098] - breeding Golden Plover (*Pluvialis apricaria*) [A140] - breeding Common Gull (*Larus canus*) [A182] - breeding
Rahasane Turlough SPA [004089]	13.2km	Whooper Swan (*Cygnus cygnus*) [A038] - wintering Wigeon (*Anas penelope*) [A050] - wintering

Site Name	Distance[16]	Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)
		Golden Plover (*Pluvialis apricaria*) [A140] - wintering Black-tailed Godwit (*Limosa limosa*) [A156] - wintering Greenland White-fronted Goose (*Anser albifrons flavirostris*) [A395] - wintering Wetlands & Waterbirds [A999]

A summary of the biodiversity baseline for each of these European sites is provided below, with more detailed baseline information on each of these sites presented in Section 9 of the Natura Impact Statement (NIS).

8.3.3.1.1 Lough Corrib cSAC

The proposed road development and its boundary overlaps with, i.e. traverses through or adjacent to one Euroepean site, namely Lough Corrib cSAC at four locations: at the termination of the proposed drainage outfall from the N59 Link Road North at Kentfield; at the site of the proposed River Corrib Bridge between Dangan and Menlough; to the west of the Coolagh Lakes (Ch. 9+850 to Ch. 10+100); and, to the west and north of Lackagh Quarry where the proposed road development will consist of a tunnel (Lackagh Tunnel) and approach road infrastructure.

The full results of the habitat surveys carried out in Lough Corrib cSAC in 2014 are presented in *N6 Galway City Transport Project – Habitat mapping and assessment of a section of Lough Corrib cSAC and surrounding areas* (Barron et al., 2017), which is included in **Appendix A.8.5**.

In summary, a total of 16 Annex I habitats, covering c.155.2ha, were recorded during the survey of Lough Corrib cSAC between Coolanillaun and Galway City, not all of which were located within Lough Corrib cSAC:

- Dystrophic lakes [3160]
- Wet heaths [4010]
- Dry heaths [4030]
- Alpine and Boreal heaths [4060]
- Calcareous grasslands [6210]
- Orchid-rich calcareous grasslands [*6210]
- *Molinia* meadows [6410]
- Hydrophilous tall-herb communities [6430]
- *Cladium* fens [*7120]
- Blanket bog (inactive) [7130]
- Blanket bog (active) [*7130]
- Transition mires and quaking bogs [7140]
- Alkaline fens [7230]

- Limestone pavement (exposed) [*8240]
- Limestone pavement (wooded) [*8240]
- Alluvial forests [*91E0]

The majority of these habitat types form part of, and are supported by, the wetland complex along the River Corrib corridor and associated with the Coolagh Lakes. The drier heath, grassland and exposed limestone rock habitats are predominantly located on the slopes of an elevated hill to the north of the Coolagh Lakes (the Coolagh Lakes also supports smaller areas of these habitat types beyond the wetland margins).

The River Corrib itself was classified as a Depositing/lowland river (FW2) as part of aquatic habitat surveys carried out in 2014 (**Appendix A.8.20**). The River Corrib channel in the vicinity of the proposed road development, or further downstream, does not correspond with any Annex I habitat type.

Downstream of the proposed River Corrib Bridge, the habitats present within Lough Corrib cSAC along the river banks consists of a mosaic of Wet grassland (GS4) and Reed swamp (FS1). Scrub (WS1), Dry calcareous and neutral grassland (GS1) and woodland (WD1, WN2 and WN6) are also present between the proposed crossing point for the River Corrib Bridge and the Coolagh Lakes. Many of these habitat types correspond with the Annex I habitat types[18] Calcareous grassland [6210], Residual alluvial forests [*91E0], *Cladium* fen [*7210], Hydrophilous tall herb [6430] and Transition mires [7140]. Although only Calcareous grassland and *Cladium* fen are QI habitats for Lough Corrib cSAC, many of the other wetland habitats are likely to provide a supporting role to these habitats within this mosaic.

The proposed drainage outfall from the N59 Link Road North will discharge to a drainage ditch in Lough Corrib cSAC at Kentfield. Habitats in this area included Treeline (WL2), Scrub (WS1) and Dry meadows and grassy verges (GS2), Wet grassland and Reed and large sedge swamp/Tall-herb swamp/Wet grassland (FS1/FS2/GS4). A patch of *Phragmites australis* Reed swamp (FS1) and an area of Rich fen and flush (PF1) are immediately to the east of the proposed development boundary. The fen area corresponds with the PF1_RFLU1a [19] vegetation community (*Carex viridula oedocarpa - Pinguicula vulgaris - Juncus bulbosus* flush; brown moss sub-community) of the Annex I habitat type *Alkaline fens* [7230].

The drainage ditch, to which the drainage outfall discharges, drains to the north-west for c.380m before turning north-east where it connects with the River Corrib after a further c.130m. Along or close to the drainage ditch, within the boundary of Lough Corrib cSAC, are Wet grassland (GS4), Wet heath (HH3), Transition mire (PF3) and Wet willow-alder-ash woodland (WN6) habitats. Some of these

[18] Where abbreviated Annex I habitat names are used throughout this report, nomenclature follows that of *The Status of EU Protected Habitats and Species in Ireland. Overview Volume 1.* (National Parks & Wildlife Service, 2013a)

[19] Alkaline fen vegetation community classification as per the classification system described in Perrin, P.M., Barron, S.J., Roche, J.R. & O'Hanrahan, B. (2014). *Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. Irish Wildlife Manuals, No. 79.* National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

correspond with Annex I habitat types: *Molinia* meadow [6410], Wet heath [4010], Transition mire [7140] and Residual alluvial forests [*91E0], respectively.

The Coolagh Lakes correspond with the Annex I Hard water lakes [3140] habitat type and support a wetland complex of Wet grassland (GS4), Wet heath (HH3), Fen (Pf1 and PF2) and Reed swamp (FS1). Many of these habitat types correspond with the Annex I habitat types[20] Residual alluvial forests [*91E0], *Cladium* fen [*7210], Alkaline fen [7230], Hydrophilous tall herb [6430], *Molinia* meadow [6410], Wet heath [4010] and Transition mires [7140]. Although only Calcareous grassland and *Cladium* fen are QI habitats for Lough Corrib cSAC, many of the other wetland habitats are likely to provide a supporting role to these habitats within this mosaic.

The area to the west of the Coolagh Lakes and to the north and east towards Lackagh Quarry consisted of a mosaic of Exposed calcareous rock (ER2), Dry calcareous and neutral grassland (GS1), Oak-Ash-Hazel Woodland (WN2) and Scrub (WS1). Some of these areas corresponded with the Annex I habitats Calcareous grassland [*6210/6210] and Limestone pavement [*8240].

Otter use the River Corrib Corridor (although no holt or couch sites were present in the vicinity of the proposed road development). The River Corrib is an important salmonid watercourse, supporting both Atlantic salmon and Brown trout. There are records of Sea lamprey spawning below the Salmon Weir in Galway City (O'Connor, 2007) and the species has also been recorded by IFI spawning in the upper catchment in Cong, Co. Mayo. Brook lamprey have been recorded widely throughout the River Corrib catchment (O'Connor, 2007). No suitable lamprey ammocoete nursery habitat was recorded in the vicinity of the proposed River Corrib Bridge, or the proposed drainage outfalls to the river.

Whilst there are no records of Atlantic salmon or Sea lamprey at the proposed River Corrib Bridge crossing, the River Corrib provides important habitat for Atlantic salmon, and both lamprey species, particularly in the context of its function as a migration corridor from the sea to the spawning areas for Atlantic salmon and Sea lamprey.

8.3.3.1.2 Galway Bay Complex cSAC

The proposed road development does not traverse the Galway Bay Complex cSAC and given that it lies downstream of the proposed road development, the description here is focussed on the downstream coastal and marine habitats, and the QI species they support, which are the QIs which fall within the zone of influence of the proposed road development. The descriptions are based upon the information presented in the conservation objectives for Galway Bay Complex cSAC, and the relevant supporting documents, and presents summary of the site as a whole.

Galway Bay is classified as the Annex I habitat Large shallow inlets and bays [1160], associated with which are Reefs [1170], Tidal mudflats [1140], Lagoons [*1150], Salicornia mud [1310], Perennial vegetation of stony banks [1220] and Atlantic salt meadows [1330]. These habitats are also supported by a network of

[20] Where abbreviated Annex I habitat names are used throughout this report, nomenclature follows that of *The Status of EU Protected Habitats and Species in Ireland. Overview Volume 1.* (National Parks & Wildlife Service, 2013a)

other habitat types including the freshwater rivers and streams that flow into the bay, the transitional waters of the estuary and terrestrial habitat along the coastline.

Rusheen Bay, to which some of the rivers/streams crossed by the proposed road development will drain (Bearna Stream catchment and the Knocknacarragh Stream), comprises a mosaic of most of these habitat types: Large shallow inlets and bays [1160], associated with which are Reefs [1170], Tidal mudflats [1140], Perennial vegetation of stony banks [1220] and Atlantic salt meadows [1330].

The habitats within Galway Bay also support Qualifying Interests (QI) populations of Otter and Harbour seal.

8.3.3.1.3 Lough Corrib SPA

Lough Corrib SPA is a vast site comprising Lough Corrib, most of its islands, and much of the wetland habitat that surrounds the lake margin. The proposed road development does not traverse the Lough Corrib SPA. However, the closest areas of such wetland habitat to the proposed road development are at Tonacurragh and Coolanillaun where there is a wetland mosaic of bog, heath, reed swamp, marsh and wet grassland habitats.

Although this SPA lies outside, and upstream of, the proposed road development, many bird species listed as Special Conservation Interests (SCIs) of the SPA were recorded at winter bird survey sites across the scheme study area. The habitat types associated with these sites ranged from natural/semi-natural lakes and wetland complexes (Ballindooley Lough, Coolagh Lakes and Lough Inch), the River Corrib, and upland mosaics of bog, heath, wet and acid grasslands, to improved and intensively managed habitats such as agricultural fields and amenity areas within Galway City (e.g. NUIG Sporting Campus).

There were two bird species recorded during the breeding bird surveys which are SCIs of Lough Corrib SPA for their breeding population: Common tern and Black-headed gull. This is generally consistent with the findings of the surveys carried out along the River Corrib corridor in 2005/2006 for the N6 Galway City Outer Bypass Scheme (RPS, 2006), where these species were recorded frequently over the summer months along the river, but in low numbers. The 2005/2006 surveys also recorded another breeding SCI species frequently on the River Corrib during the summer months; Common gull.

Seven bird species which are listed as wintering SCI species for Lough Corrib SPA were recorded at winter bird survey sites within the ZoI of the proposed road development:

- Black-headed gull
- Common gull
- Coot
- Golden plover
- Hen harrier
- Shoveler

- Tufted duck

8.3.3.1.4 Inner Galway Bay SPA

As Inner Galway Bay SPA covers approximately the same area as Galway Bay Complex cSAC, refer to the habitat description above in **Section 8.3.3.1.2**. The habitats within the SPA support the SCI bird species, providing nesting, foraging and roosting sites which include open water, intertidal and terrestrial habitats.

As noted above for Lough Corrib SPA, bird species listed as winter SCI species of the Inner Galway Bay SPA were recorded at many of the winter bird survey sites across the scheme study area, the majority of which are remote from the SPA itself.

There were two bird species recorded during the breeding bird surveys which are listed as SCIs of Inner Galway Bay SPA for their breeding population: Common tern (along the River Corrib) and Cormorant (flying overhead in the vicinity of the River Corrib corridor and in the western part of the scheme study area).

These results are generally consistent with the findings of the surveys carried out along the River Corrib corridor in 2005/2006 for the N6 Galway City Outer Bypass project (RPS, 2006), where these species were recorded frequently over the summer months along the river, but in low numbers.

Twelve bird species which are listed as winter SCI species for Inner Galway Bay SPA were recorded within winter bird survey sites within the ZoI of the proposed road development:

- Bar-tailed godwit
- Black-headed gull
- Common gull
- Cormorant
- Curlew
- Golden plover
- Grey heron
- Lapwing
- Redshank
- Shoveler
- Teal
- Wigeon

8.3.3.2 Natural Heritage Areas & proposed Natural Heritage Areas

National Heritage Areas (NHAs) are designations under Section 16 of the Wildlife Acts to protect habitats, species or geology of national importance.

In addition to NHAs there are proposed NHAs (referred to as pNHAs), which are also sites of significance for wildlife and habitats and were published on a non-statutory basis in 1995, but have not since been statutorily proposed or designated. Proposed NHAs are offered protection in the interim period under the county or city development plans which requires that planning authorities give due regard to their protection in planning policies and decisions[21].

Many of the pNHA sites, and some of the NHAs, in Ireland overlap with the boundaries of European sites.

Only one of these, Lough Corrib pNHA is crossed by the proposed road development. There are three NHAs and 18 pNHAs located within 15km of the proposed development boundary (**Figure 8.13.1**). **Table 8.5** below lists these sites, their distance from the proposed development boundary, and the ecological features for which the sites are designated/proposed.

Table 8.5: Natural Heritage Areas (and proposed Natural Heritage Areas) within 15km of the proposed development boundary

Natural Heritage Areas		
Site Name	**Distance[22]**	**Features of Interest**
Moycullen Bogs NHA [002364]	80m at Na Foraí Maola Thiar Immediately adjacent to the proposed development boundary at Ballagh	Peatland [T010]
Cregganna Marsh NHA [000253]	4km	Birds [12] - see Cregganna Marsh SPA above
Oughterard District Bog NHA [002431]	15km	Peatland [T010]
Proposed Natural Heritage Areas		
Site Name	**Distance**	**Description**
Lough Corrib pNHA [000297]	crossed by the proposed road development	See above under Lough Corrib cSAC and Lough Corrib SPA
Galway Bay Complex pNHA [000268]	190m	See above under Galway Bay Complex cSAC and Inner Galway Bay SPA
Furbogh Wood pNHA [001267]	2.3km	Oak woodland

[21] For example, Policy 4.2 of the *Galway City Development Plan 2017-2023* includes a commitment to "Protect, conserve and promote the nationally designated sites of ecological importance, including existing and proposed Natural Heritage Areas (NHAs and pNHAs) in the city".

[22] Distance in km/m from the proposed road development

Proposed Natural Heritage Areas		
Site Name	**Distance**	**Description**
Kiltullagh Turlough pNHA [000287]	2.2km	Turlough feature
Ballycuirke Lough pNHA [000228]	4.6km	Lake and associated wetland habitats - part of Lough Corrib cSAC
Connemara Bog Complex pNHA [002034]	6km	See above under Connemara Bog Complex cSAC and Connemara Bog Complex SPA
Killarainy Lodge, Moycullen pNHA [002083]	7.2km	Natterer's bat nursery roost
Drimcong Wood pNHA [001260]	8.2km	Mixed broadleaved and coniferous woodland
Ross Lake and Woods pNHA [001312]	10.2km	See above under Ross Lake And Woods cSAC
Black Head-Poulsallagh Complex pNHA [000020]	10.6km	See above under Black Head-Poulsallagh Complex cSAC
Lough Fingall Complex pNHA [000606]	11.1km	See above under Lough Fingall Complex pNHA
Rahasane Turlough pNHA [000322]	13.3km	See above under Rahasane Turlough SAC and Rahasane Turlough SPA
Gortnandarragh Limestone Pavement pNHA [001271]	13.4km	See above under Gortnandarragh Limestone Pavement cSAC
Moneen Mountain pNHA [000054]	13.3km	See above under Moneen Mountain cSAC
East Burren Complex pNHA [001926]	13.5km	See above under East Burren Complex cSAC
Kiltiernan Turlough pNHA [001285]	13.9km	See above under Kiltiernan Turlough cSAC
Castletaylor Complex pNHA [000242]	14km	See above under Castletaylor Complex cSAC
Turloughcor pNHA [001788]	15km	Wetland site supporting wintering bird populations

8.3.4 Habitats

Overview

The results of the habitat surveys along the route of the proposed road development are described below by habitat type, after Fossitt (2000, see also **Appendix A.8.6**), and where relevant include a description of any corresponding Annex I habitat types that were present (see also **Appendix A.8.3** and **Appendix A.8.4** for results of habitat surveys). The habitats described below relate to habitat polygons within or adjacent to the proposed road development, as shown on **Figures 8.14.1** to **8.14.15** and **Figures 8.15.1** to **8.15.15** along with the full habitat survey results. Full species lists for each habitat type are provided in **Appendix A.8.19**. In general, habitats are described from east to west under the headings below.

The results and summary of the findings of the aquatic habitat surveys have been incorporated into the relevant habitat descriptions below. A full description and species lists are provided in **Appendix A.8.20**.

The habitat types recorded along the route of the proposed road development, and discussed in this section, are as follows:

- Flower beds and borders (BC4)
- Buildings and artificial surfaces (BL3)
- Spoil and bare ground (ED2)
- Recolonising bare ground (ED3)
- Active quarries and mines (ED4)
- Exposed siliceous rock (ER1)
- Exposed calcareous rock (ER2), including the priority Annex I habitat *8240
- Limestone/marl lakes (FL3), including the Annex I habitat 3140
- Mesotrophic lakes (FL4)
- Eutrophic lakes (FL5)
- Turloughs (FL6), which corresponds with the priority Annex I habitat *3180
- Other artificial lakes and ponds (FL8)
- Calcareous springs (FP1), including the priority Annex I habitat *7220
- Reed and large sedge swamps (FS1), including the priority Annex I habitats *7210 and the Annex I habitat 6430
- Tall-herb swamps (FS2), including the Annex I habitats 6430/*7210
- Eroding/upland rivers (FW1)
- Depositing/lowland rivers (FW2)
- Drainage ditches (FW4)
- Improved agricultural grassland (GA1)
- Amenity grassland (improved) (GA2)

- Marsh (GM1)
- Dry calcareous and neutral grassland (GS1), including the priority Annex I habitat *6210/Annex I habitat 6210
- Dry meadows and grassy verges (GS2), including the Annex I habitat 6510
- Dry-humid acid grassland (GS3), including the priority Annex I habitat *6230
- Wet grassland (GS4), including the Annex I habitat 6410
- Dense bracken (HD1)
- Dry siliceous heath (HH1), which corresponds with the Annex I habitat 4030
- Dry calcareous heath (HH2), which corresponds with the Annex I habitat 4030
- Wet heath (HH3), which corresponds with the Annex I habitat 4010
- Rich fen and flush (PF1), including the Annex I habitats 7230/*7210
- Poor fen and flush (PF2)
- (Mixed) broadleaved woodland (WD1)
- Mixed broadleaved/conifer woodland (WD2)
- (Mixed) conifer woodland (WD3)
- Scattered trees and parkland (WD5)
- Hedgerows (WL1)
- Treelines (WL2)
- Oak-ash-hazel woodland (WN2), including the priority Annex I habitat *8240
- Wet willow-alder-ash woodland (WN6), including the priority Annex I habitat *91E0
- Scrub (WS1), including the priority Annex I habitat *8240
- Immature woodland (WS2)
- Ornamental/non-native shrub (WS3)
- Recently-felled woodland (WS5)

Summary of Underlying Geology and Habitat Type

As a consequence of the underlying geology, with the western part of the study area underlain by granite and the eastern by limestone, the nature of the habitats present across the study area were generally acidic west of the N59 Moycullen Road and calcareous to the east.

West of the River Corrib, the habitats generally consisted of a mosaic of agricultural fields, peatland/heath habitats, and scrub, separated into distinct habitat blocks of varying sizes by the local road network and the associated linear residential development. The character of the agricultural fields varied from intensively managed farmland through to abandoned fields overgrown with scrub and bracken. The peatland habitat blocks consisted of predominantly wet heath, dry heath and bog mosaics, with those habitat patches closest to the proposed road development either the edges of larger peatland habitat blocks or smaller, more isolated, remnant patches. Small areas of fen and transition mire were also present. Given the close proximity of Galway City there were also large expanses of urban and residential development adjacent to the proposed road development, particularly around Ballyburke/Rahoon area and where the proposed road development crosses the N59 Moycullen Road at Dangan.

East of the River Corrib, there were two distinct habitat zones; from the River Corrib to the N84 Headford Road comprised of a patchwork of semi-natural woodland, limestone pavement, scrub and calcareous grassland fields. East of the N84 Headford Road was predominantly improved agricultural grasslands surrounded by residential and industrial development in Parkmore, Ballybrit, Briarhill and Doughiska. There were also two wetland complexes of note in this section: the Coolagh Lakes and Ballindooley Lough. There were also some isolated patches of semi-natural habitats, calcareous grassland and limestone pavement, in the Coolagh/Doughiska area.

8.3.4.1 Flower beds and borders (BC4)

This habitat type was widespread along the proposed road development and included ornamental planting associated with residential gardens, commercial developments or industrial complexes/ business parks. The majority of this habitat type is captured on the habitat map by the *Residential* classification (see **Section 8.3.4.34** below).

8.3.4.2 Stone walls and other stonework (BL1)

Stone walls were generally present as either field or property boundaries. In the western part of the study area, many of the stone wall field boundaries were overgrown with scrub and bracken. Plant species recorded in association with the stone walls included: *Asplenium trichomanes*, *Hedera helix*, *Polypodium vulgare*, *Frullania dilatata*, the moss species *Brachythecium rutabulum*, *Dicranum scoparium*, *Homalothecium sericeum*, *Hypnum cupressiforme*, *Isothecium myosuroides*, *Mnium hornum*, *Racomitrium fasciculare* and lichens such as *Cladonia* spp. and other crustose lichens.

8.3.4.3 Buildings and artificial surfaces (BL3)

This classification included buildings (domestic, commercial and industrial), roads, car parks, artificial recreation surfaces (e.g. Astroturf pitches) and other concrete/hard standing areas (e.g. quarrying infrastructure at Lackagh Quarry). Aside from residential properties/developments, the largest expanses of this habitat type within, or adjacent to, the proposed road development were associated with the business parks at Ballybrit, Parkmore and Briarhill, and at the Galway Racecourse. In the case of residential properties, the majority of this habitat type is captured on the habitat map by the *Residential* classification (see **Section 8.3.4.34** below).

8.3.4.4 Spoil and bare ground (ED2)

Across the study area, this habitat type consisted of small areas of bare ground associated with access tracks (either permanent and maintained lanes, or recently cleared ground) or, in the case of the larger expanses at Ballyburke and adjacent to the N59 Link Road North near Bushypark, lands which had been recently cleared for development.

8.3.4.5 Recolonising bare ground (ED3)

Generally small areas of disturbed ground were recorded along the route of the proposed road development but there were a number of larger areas associated with development sites, or larger scale scrub clearance of agricultural fields.

Along the western part of the proposed road development, the cover and composition of recolonising bare ground vegetation varied widely, dependant on the soil type and surrounding drainage. Species included tree/shrub species such as Salix cinerea and Ulex europaeus; the grasses Agrostis capillaris, Agrostis stolonifera, Holcus lanatus and Poa annua; rush and sedge species such as Juncus effusus and Carex disticha; and herb species including Achillea millefolium, Anagallis arvensis, Centaurea nigra, Cirsium arvense, Daucus carota, Hypericum pulchrum, Hypochaeris radicata, Lotus corniculatus, Plantago lanceolata, Plantago major, Potentilla anserina, Senecio jacobaea and Tussilago farfara. Where soils were more acidic/peaty in nature (e.g. at Ch. 4+900 to Ch. 5+000), recolonising ground was characterised by heath species such as Calluna vulgaris, Molinia caerulea, Carex panicea and Ulex gallii in places.

Along the eastern part of the proposed road development, recolonising bare ground included the following species, many of which reflected the calcareous nature of the surrounding habitats in this area: the grasses *Agrostis canina*, *Anthoxanthum odoratum*, *Arrhenatherum elatius*, *Cynosurus cristatus*, *Dactylis glomerata*, *Festuca rubra* and *Poa pratensis*; and herb species such as *Achillea millefolium*, *Centaurium erythraea*, *Euphrasia officinalis* agg., *Hypericum perforatum*, *Lotus corniculatus*, *Leontodon autumnalis*, *Leucanthemum vulgare*, *Linum catharticum*, *Medicago lupulina*, *Odontites verna*, *Potentilla reptans*, *Primula veris*, *Prunella vulgaris*, *Ranunculus repens*, *Senecio jacobaea*, *Succisa pratensis*, *Tussilago farfara* and *Ulex europaeus*.

8.3.4.6 Active quarries and mines (ED4)

Lackagh Quarry was the only quarry site within the proposed development boundary and is an inactive quarry. The quarry was surrounded on the west, north, and eastern sides by high, vertical cliff faces and, despite being sparsely vegetated for the most part, had a diverse assemblage of plant species reflecting the calcareous nature of the substrate and the damp areas created by the seepage lines from the quarry walls: tree/shrub species including *Acer pseudoplatanus*, *Alnus incana* and *Salix cinerea*; and herb species such as *Agrostis stolonifera*, *Anagallis arvensis*, *Asplenium ruta-muraria*, *Blackstonia perfoliata*, *Carex flacca*, *Centaurea nigra*, *Epilobium montanum*, *Epipactis helleborine*, *Equisetum fluviatile*, *Hypericum pulchrum*, *Hypericum tetrapterum*, *Leontodon hispidus*, *Leucanthemum vulgare*, *Linum catharticum*, *Lotus corniculatus*, *Mycelis muralis*, *Petasites fragrans*, *Phyllitis scolopendrium*, *Pimpinella major*, *Plantago lanceolata*, *Potentilla sterilis*, *Senecio jacobaea* and *Solidago virgaurea*. The spring sites in the quarry are discussed separately below under *Calcareous springs*.

8.3.4.7 Exposed siliceous rock (ER1)

Outcropping granite was recorded along the western sections of the proposed road development; most often in association with patches of dry heath on higher ground but also found on raised ground in less intensively managed agricultural fields, and in some residential gardens. Where it was recorded in a mosaic with heath habitats it is mapped and valued as the associated Annex I habitats. Where associated with improved grasslands or exposed rock slabs in residential gardens it is valued as being of a local importance (lower value).

8.3.4.8 Exposed calcareous rock (ER2)

Exposed limestone was recorded widely across the eastern part of the scheme study area. The highest concentrations were present in the area between Menlough Village, Coolough Village, Coill Uachtair and the area surrounding Lackagh Quarry. There was also a relatively large area adjacent to the southern boundary of the Roadstone Quarry at Two-mile-ditch with more isolated, scattered patches in the local area between here and the existing N6 – the most notable of which lay to the south-east of the existing Coolagh Junction.

At all locations, bar the area at Business Park Junction 2, these areas corresponded with the exposed limestone pavement group of the priority Annex I habitat *Limestone pavements* [*8240]. The exposed calcareous rock at Business Park Junction 2 comprised the vertical limestone rock faces in a small abandoned quarry and therefore, did not correspond with the Annex I habitat type.

Limestone pavement consisted of both the 'block' and 'shattered' variants of Limestone pavement (after Wilson & Fernandez, 2013), with the shattered type being most frequent. The exposed variant also included areas of limestone pavement which were being invaded by scrub (almost invariably *Corylus avellana*) which was not yet forming a continuous canopy and was less than 3m in height. The main vascular species included scattered low-growing woody species (e.g. *Hedera helix*, *Rosa spinosissima* or *Rubus fruticosus* agg., or immature *Corylus avellana* or *Ilex aquifolium*) and herbaceous species like *Carex flacca*, *Carlina vulgaris*, *Geranium robertianum*, *Mycelis muralis*, *Senecio jacobaea*, *Sesleria caerulea* and *Teucrium scorodonia*. A suite of calcicole ferns was usually found comprising *Asplenium ruta-muraria*, *Ceterach officinarum* and, in the deeper clefts (grykes), the shade-loving *Phyllitis scolopendrium*. Characteristic bryophytes were *Ctenidium molluscum*, *Neckera crispa* and *Tortella tortuosa*.

The exposed variant of the Annex I Limestone pavement habitat type (LPE) within the ZoI of the proposed road development is summarised below in **Table 8.6** below.

Table 8.6: Areas of the exposed variant of the Annex I habitat Limestone pavement [*8240] within the potential ZoI of the proposed road development

Area	Vegetation Community[23]
South of Bóthar Nua at Ch. 10+040 (outside of any European site)	LPE_1b *Teucrium scorodonia - Sesleria caerulea* pavement
North of Bóthar Nua at Ch. 10+200 – Ch. 10+250 (outside of any European site)	LPE_1b *Teucrium scorodonia - Sesleria caerulea* pavement
Within Lough Corrib cSAC Western and northern boundaries of Lackagh Quarry between Ch. 10+900 and Ch. 11+800	LPE_1b *Teucrium scorodonia - Sesleria caerulea* pavement LPE_1d *Mycelis muralis - Fissidens dubius* pavement 1e *Corylus avellana - Neckera crispa* pavement
Along the eastern boundary of Lackagh Quarry (outside of any European site)	LPE_1b *Teucrium scorodonia - Sesleria caerulea* pavement
South-east of the Coolagh Junction (between N6 and R446) (outside of any European site)	LPE_1e *Corylus avellana - Neckera crispa* pavement

8.3.4.9 Limestone/marl lakes (FL3)

There were two distinct lake complexes present in the vicinity of the proposed road development: Coolagh Lakes and Ballindooley Lough. All of the lakes that make up the Coolagh Lakes complex, and the main waterbody at Ballindooley, corresponded with this habitat classification and the Annex I habitat type *Hard oligo- mesotrophic waters with benthic vegetation of charophytes* [3140]. The full description and aquatic plant species lists for these lakes – and all others surveyed as part of the aquatic habitat survey – are provided in **Appendix A.8.20**.

Coolagh Lakes

The upper lake contained some flowering plants including *Hippuris vulgaris*, *Myriophyllum spicatum*, *Nuphar lutea* and *Elodea canadensis* (which grew at the base of the euphotic zone at about 4m, as did some *Lemna trisulca*). However, *Chara rudis* or *Chara hispida* dominated most of the euphotic zone.

The lower lake also contained large stands of *Chara hispida* and *Chara rudis*, but flowering plants were more abundant with *Lemna trisulca* forming a zone at the base of the euphotic zone (4m) and *Elodea canadensis* intermixed with the *Chara* species. Other species included *Potamogeton lucens*, *Sparganium* sp., *Myriophyllum spicatum* and *Utricularia cf. vulgaris*. Two other species of charophyte, *Chara contraria* and *Chara vulgaris* occurred in small quantities. The lower lake however, was considered to be the borderline eutrophic type FL5 (and not an exceptionally good example of the habitat type), due to the increased

[23] The vegetation communities are assigned based upon the plant species recorded and with reference to the vegetation types described in *National survey of limestone pavement and associated habitats in Ireland. Irish Wildlife Manuals, No. 73* (Wilson, S. and Fernández, F., 2013)

presence of *Elodea canadensis* and *Lemna trisulca* (most likely as a result of eutrophication) and the presence of the non-native invasive Zebra mussel *Dreissena polymorpha*.

Ballindooley Lough

The sub-littoral vegetation was dominated by charophyte algae. *Chara rudis* was exceptionally abundant from 0-3m with some other species occurring in very shallow water including *Chara aspera*, *Chara aculeolata* and *Chara curta*. Flowering plants were rare, as is often the case in marl lakes, with only *Elodea canadensis* and *Utricularia* cf. *vulgaris* observed. The complete dominance of *Chara rudis* however, probably indicates some degree of eutrophication. The rather turbid lake water would support this conclusion. Most of the lake was deeper than the euphotic depth of about 4m and no plants were found.

8.3.4.10 Mesotrophic lakes (FL4)

The smaller circular pond (531194 728778 ITM) at Ballindooley – the northernmost of the three small lakes present – corresponded with this habitat type. It had floating plant species present including *Potamogeton natans*, *Nymphaea alba* and *Sparganium natans*. Sublittoral species included abundant *Chara virgata and Utricularia cf. vulgaris*.

There was also a more transient small lake along the eastern edge of the main lake complex at the Coolagh Lakes (which was dry when surveyed). The aquatic plant species *Typha latifolia* and *Hippuris vulgaris* were present.

8.3.4.11 Eutrophic lakes (FL5)

Two of the small lakes at Ballindooley corresponded with this habitat type. The oval shaped pool nearest the residential houses (ITM grid reference 531244 728619) was shallow with a sublittoral flora of *Elodea canadensis*, *Lemna trisulca* and *Fontinalis antipyretica*. Floating species included *Nymphaea alba*. The abundance *of Lemna* and *Elodea* indicated a eutrophic pond.

The smallest water body, directly south of the main lake (531473 728626 ITM), had *Potamogeton natans*, *Hippuris vulgaris*, *Elodea canadensis*, *Alisma plantago-aquatica* and *Ranunculus trichophyllus* present; suggestive of eutrophic conditions.

8.3.4.12 Turloughs (FL6)

There is one turlough feature within the ZoI of the proposed road development: between Bóthar Nua and Seanbóthar in the Menlough area at Ch. 10+320. Turloughs are depressions, generally in limestone areas, which are intermittently inundated with groundwater and support wetland habitats.

The turlough feature at Menlough corresponded with the priority Annex I habitat type *Turloughs* [*3180] and the *Potentilla anserina-Carex nigra* vegetation community (Waldren, 2015, Ed.). The vegetation was typical turlough marsh vegetation including the following species: *Potentilla anserina*, *Apium inundatum*, *Eleocharis palustris*, *Caltha palustris*, *Rumex crispus*, *Agrostis stolonifera*, *Ranunculus repens*, *Senecio aquaticus*, *Prunella vulgaris*, *Myosotis aquatica*, *Persicaria amphibia*, *Mentha aquatica*, *Glyceria fluitans*, *Filipendula ulmaria*, *Urtica dioica*, *Persicaria maculata*, *Rumex obtusifolius*, *Equisetum palustre* and *Veronica catenata*. Although not associated directly with the ground vegetation, the moss species *Cinclidotus fontinaloides* – a characteristic turlough species – was recorded on stone walls within the turlough feature.

The Turlough habitat within the ZoI of the proposed road development is summarised below in **Table 8.7** below.

Table 8.7: Areas of the Annex I habitat Turloughs [*3180] within the potential ZoI of the proposed road development

Area	Vegetation Community24
Between Bóthar Nua and Seanbóthar in the Menlough/Coolough area at Ch. 10+320 outside a European site	6b Wet Carex nigra vegetation community (Goodwillie, 1992) Potentilla anserina-Carex nigra vegetation community (Waldren, 2015, Ed.)

8.3.4.13 Other artificial lakes and ponds (FL8)

Artificial ponds were present at the proposed Coolagh Junction (road drainage attenuation ponds) and in Lackagh Quarry (associated with the gravel washout area). The plant species associated with the attenuation ponds are described below under the FS1 habitat descriptions; there was no vegetation associated with the gravel washout ponds at Lackagh Quarry.

8.3.4.14 Calcareous springs (FP1)

A total of 27 calcareous springs/seepage lines were recorded in Lackagh Quarry. Of these, 23 had vegetation associated with the seepage line. The most frequently recorded vascular plant species associated with the springs/seepage lines were *Tussilago farfara*, *Leontodon hispidus*, *Carex flacca*, *Epilobium parviflorum*, *Festuca rubra*, *Sonchus oleraceus*, *Holcus lanatus*, *Lotus uliginosus* and *Sesleria caerulea*; the most frequently recorded moss species were *Dicranella varia*, *Didymodon tophaceus*, *Fissidens adianthoides* and *Pellia endiviifolia*.

Six of the springs/seepages (all located on the west face of the quarry) conformed to the priority Annex I habitat *Petrifying springs with tufa formation (Cratoneurion)* [*7220], as the following indicator species for the Annex I habitat type were recorded growing in conjunction with tufa deposits on the cliff faces: *Didymodon tophaceus*, *Pellia endiviifolia*, *Festuca rubra*[25]. The Petrifying springs present were

[24] The vegetation communities are assigned based upon the plant species recorded and with reference to the vegetation types described in *Turloughs over 10 ha: vegetation survey and evaluation* (Goodwillie, R., 1992) and *Turlough Hydrology, Ecology and Conservation* (Waldren, S. 2015, Ed.)

[25] Although these indicator species recorded are not listed as such in the *Interpretation manual of European Union Habitats* EUR28 (CEC, 2013), in an Irish context they are considered by the NPWS to be indicator species for [*7220] (NPWS, 2013b)

generally species poor and considered marginal examples of the habitat type, lacking many of the key indicative species and generally limited in extent; in some cases, occurring only in the immediate vicinity of cushions of *Didymodon tophaceus*. They are also only present due to human activity, with the quarrying of limestone resulting in the creation of suitable habitat for their formation.

The full results of the Petrifying spring survey at Lackagh Quarry are provided in **Appendix A.8.21**.

8.3.4.15 Reed and large sedge swamps (FS1)

Along the western part of the proposed road development, there were scattered small patches of species poor reed swamp in the vicinity of the proposed road development; mostly located along the margins of peatland areas. The vegetation was typically dominated by *Phragmites australis*.

Along the banks of the River Corrib and around parts of the Coolagh Lakes, reed swamp habitat was typically dominated by *Phragmites australis* with species such as *Phalaris arundinacea*, *Typha latifolia*, *Sparganium erectum*, *Equisetum fluviatile*, *Menyanthes trifoliata*, *Epilobium hirsutum*, *Calystegia sepium*, *Lycopus europaeus*, *Lysimachia vulgaris*, *Mentha aquatica*, *Angelica sylvestris*, *Valeriana officinalis*, *Filipendula ulmaria* and *Lythrum salicaria* also present.

Two small areas of reed swamp on the margins of the Coolagh Lakes corresponded with the Annex I habitat type *Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels* [6430], where herb species indicative of this habitat type such as *Calystegia sepium*, *Epilobium hirsutum* and *Equisetum fluviatile* were more abundant amongst the reed stands.

Where *Cladium mariscus* was more dominant, reed swamps corresponded with the priority Annex I habitat type *Calcareous fens with Cladium mariscus and species of the Caricion davallianae* [*7210]. This habitat was abundant around the Coolagh Lakes, but was also recorded to a lesser extent along the backwater to the east of Jordan’s Island and in small patches along the banks of the River Corrib. Other plant species associated with this Annex I habitat type included: *Phragmites australis*, *Calystegia sepium*, *Equisetum fluviatile*, *Lysimachia vulgaris*, *Epilobium hirsutum*, *Mentha aquatica* and *Schoenus nigricans*.

At Ballindooley Lough, *Phragmites australis*, *Schoenoplectus lacustris* and *Cladium mariscus* were the typical species in the reed swamp habitat around the lakes’ margins. As above, the *Cladium mariscus* swamp, which was present at two locations at Ballindooley Lough, corresponded with the priority Annex I *Cladium* fen habitat type.

The existing N6 attenuation ponds at Briarhill supported a relatively species rich wetland for such a man-made feature, including: *Phragmites australis*, *Typha latifolia*, *Sparganium erectum*, *Schoenoplectus lacustris*, *Apium nodiflorum*, *Nasturtium officinale*, *Lemna minor* and *Epilobium hirsutum*.

8.3.4.16 Tall-herb swamps (FS2)

The majority of the tall-herb swamp was recorded along the banks of the River Corrib and around the margins of the Coolagh Lakes – where larger areas were present in the wetland extending north from the lakes, either side of Bóthar Nua.

The most frequently recorded species were *Carex disticha*, *Epilobium hirsutum*, *Equisetum fluviatile*, *Filipendula ulmaria*, *Calliergonella cuspidata*, *Festuca arundinacea*, *Lysimachia vulgaris*, *Phragmites australis*, *Mentha aquatica*, *Valeriana officinalis* and *Galium palustre*. Other typical species present included *Calystegia sepium*, *Iris pseudacorus*, *Menyanthes trifoliata*, *Sparganium erectum*, *Angelica sylvestris*, *Berula erecta* and *Lythrum salicaria*.

The majority of the FS2 areas corresponded with the Annex I habitat type *Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels* [6430].

Due to the abundance of *Cladium mariscus* a single polygon of reed-swamp, c.700m downstream of the proposed River Corrib Bridge on the west bank of the river, corresponded with the *Cladium* fen priority Annex I habitat type [*7210].

In the western part of the study area (Ch. 3+400), there was also a vegetated drain, with *Apium nodiflorum*, *Iris pseudacorus* and *Epilobium hirsutum*, recorded near An Chloch Scoilte Junction which corresponded with the FS2 classification.

8.3.4.17 Eroding/upland rivers (FW1)

The following are the eroding upland rivers crossed by the proposed road development: Sruthán na Líbeirtí (Liberty Stream), Trusky Stream, the Bearna Stream (and tributary), Tonabrocky Stream and the Knocknacarra Stream.

Many of these streams are seasonal in their upper reaches, where they are crossed by the proposed road development. Instream vegetation is generally absent, and in the vicinity of the proposed crossings for the proposed road development, is overgrown with scrub and rank vegetation from the adjacent terrestrial habitats. Where present, coverage is limited and included the following species: *Apium nodiflorum*, *Fontinalis antipyretica*, *Fontinalis squamosa*, *Hyocomium armoricum*, *Mentha aquatica*, *Nasturtium officinale* and *Ranunculus flammula*.

The physical characteristics of the various stream/river channels are described in the fisheries report in **Appendix A.8.17**. Details of the fisheries value of these watercourses is also presented in **Appendix A.8.17** and discussed in **Section 8.3.12** below.

8.3.4.18 Depositing/lowland rivers (FW2)

Two of the watercourses present within the scheme study area were classified as depositing/lowland rivers: the River Corrib and the Terryland River.

River Corrib, from Tonacurragh to Menlo Castle

The vegetation in this section of the river was dominated by charophyte algae in many places, especially *Chara rudis.* In the upper river near the junction of the Friar's Cut, the shore included backwaters dominated by reed swamp and open water with *Chara curta*, *Chara virgata annulata* and cyanobacterial crust on stones, as on the shore of Lough Corrib and other calcareous lakes. In deeper water (1m) *Chara rudis* was dominant with emergent vegetation including *Schoenoplectus lacustris* and *Phragmites australis*. *Chara rudis* extended to 2m depth along with *Zannichella palustris*, *Potamogeton lucens,* a little *Potamogeton crispus* and *Myriophyllum spicatum,* while *Chara globularis* extended to 3m along with some *Nuphar lutea* and abundant Zebra mussels. At this depth a white, shelly marl replaces the dark peat and mud of shallower water. In the main channel the river shelved very steeply and *Potamogeton perfoliatus* occurred.

Midway between the Friar's cut and Menlo Pier the river was divided by a long narrow bank vegetated with swamp (527715 728520 ITM) with species present including *Eleocharis palustris, Hippuris vulgaris, Lythrum salicaria, Ranunculus flammula, Valeriana officinalis, Iris pseudacorus, Schoenoplectus lacustris, Sparganium* sp.*, Menyanthes trifoliata, Calystegia sepium* and *Myosotis laxa*[26].

The shallower western channel, to a depth of 2m, contained reed swamp followed by *Chara virgata annulata*, *Lemna trisulca*, *Elodea canadensis* and *Nuphar lutea* in 1m depth water, and *Potamogeton perfoliatus* beds at 2m. In places, bare areas of mud were colonized *by Nitella opaca*. The main channel shelved very steeply with *Potamogeton perfoliatus*, *Lemna trisulca*, and *Elodea canadensis*, followed by bare ground with Zebra mussels.

On the east bank *Chara rudis* was dominant with some *Potamogeton berchtoldii*, *Lemna trisulca* and *Elodea canadensis*.

Below Menlo Pier the river narrowed and deepened with little vegetation other than *Potamogeton perfoliatus* and *Potamogeton natans* along with some *Chara rudis* in shallow water close to the bank.

The depth of the river varied greatly, with many shallow inshore areas, but the main channel was cut into white marl which exceeded 8m depth in places. Vegetation was largely confined to water less than 4m, but Zebra mussels occurred deeper than this. A variety of flowering plants occurred, especially pond weeds (*Potamogeton* sp.). Nearly all shallow areas of any extent were occupied by *Schoenoplectus* and *Phragmites* reed swamp.

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[26] Note that these species are provided here for information and do not appear in **Appendix A.8.20** as they were associated with the island habitat

River Corrib main channel, from Menlo Castle to the Salmon Weir

In this section of the river, vegetation was largely confined to shallow areas along the bank and was only found in depths of <2m; mainly as either reed swamp of *Phragmites australis* or *Equisetum fluviatile*, with some stands of *Potamogeton natans* and *Carex rostrata*. *Chara rudis* and some *Chara virgata* were common in the shallow sublittoral. Species composition was similar to, but less diverse than, the section upstream.

Backwater on the east side of Jordan's Island

This section consisted of small pools and channels cut through extensive *Phragmites australis*, *Schoenoplectus lacustris* and *Cladium mariscus* reed swamp. The area contained a diverse flora, especially of charophytes, but like all habitats surveyed showed signs of eutrophication. Species present include *Chara aspera, Chara contraria, Chara curta, Chara globularis, Chara rudis, Chara vulgaris and Chara virgata*. Other aquatic species included *Potamogeton pectinatus, Potamogeton perfoliatus, Potamogeton lucens, Potamogeton natans, Myriophyllum spicatum, Elodea canadensis, Berula erecta, Lemna trisulca, Nuphar lutea, Oenanthe aquatica*. Blanket weed or *Cladophora* sp. was common, suggesting eutrophication.

Terryland River

The Terryland River had a limited aquatic flora present including *Potamogeton natans*, *Callitriche* sp., *Alisma plantago aquatica*, *Chara hispida/rudis*, *Myriophyllum spicatum*, *Sparganium* sp. and *Elodea canadensis*. Large areas of bare mud and extensive development of blanket weed, *Cladophora* sp. indicated significant eutrophication and water quality was poor (see **Section 8.3.12** and **Appendix A.8.17** for the results of the macro-invertebrate water quality monitoring on the Terryland River).

8.3.4.19 Drainage ditches (FW4)

Drainage ditches were associated with agricultural fields, the margins of peatland sites, within and surrounding the Coolagh Lakes, at Ballindooley Lough, and at the Galway Racecourse.

Along the western part of the proposed road development, drainage ditches included species such as *Angelica sylvestris*, *Potamogeton polygonifolius*, *Ranunculus flammula* and *Ranunculus repens*.

Plant species associated with the drainage ditches surrounding the Coolagh Lakes included: *Apium nodiflorum*, *Lemna* sp., *Filipendula ulmaria* and *Lythrum salicaria*. The main channel connecting the Coolagh Lakes with the River Corrib was classified as a drainage ditch, fringed by very dense stands of *Phragmites australis* and *Cladium mariscus*. It was up to 1m deep with *Nuphar lutea*, *Menyanthes trifoliata*, *Elodea canadensis*, *Chara rudis*, and *Lemna trisulca* growing in the channel. *Ranunculus lingua* was conspicuous in the reed swamp on the channel edge.

The drainage ditches at Ballindooley Lough appeared to be regularly dredged and contained a limited flora of *Chara virgata*, *Chara aspera*, *Chara aculeolata*, *Chara rudis, Potamogeton coloratus* and *Lemna trisulca*.

The drainage ditches at the Galway Racecourse supported a diverse range of plant species including, *Equisetum fluviatile*, *Carex rostrata*, *Apium nodiflorum*, *Agrostis stolonifera*, *Potamogeton natans*, *Nasturtium officinale*, *Juncus articulatus*, *Typha latifolia*, *Glyceria fluitans*, *Sparganium erectum*, *Eleocharis palustris*, *Ranunculus flammula*, *Mentha aquatica*, *Galium uliginosum* and *Samolus valerandi*.

8.3.4.20 Improved agricultural grassland (GA1)

Improved agricultural grassland was present throughout, with larger areas recorded at Cappagh, between the Ballymoneen Road and Knocknabrona, around the Rahoon Road Junction, at Bushypark, in the vicinity of Bóthar Nua and Seanbóthar (Menlough/Coolough), and from the N84 Headford Road through to the existing Coolagh Junction. Characteristic species included: grass species such as *Lolium perenne*, *Agrostis stolonifera*, *Dactylis glomerata*, *Holcus lanatus*, *Poa annua*, *Poa trivialis* and *Cynosurus cristatus*; and herb species including *Trifolium repens*, *Trifolium pratense*, *Bellis perennis*, *Urtica dioica*, *Plantago lanceolata*, *Plantago major*, *Cerastium fontanum*, *Cerastium glomeratum*, *Cirsium arvense*, *Potentilla anserina*, *Ranunculus repens*, *Rumex obtusifolius*, and *Taraxacum officinale* agg.

8.3.4.21 Amenity grassland (improved) (GA2)

Other than amenity grasslands associated with residential gardens and landscaped areas in commercial/industrial complexes, the two largest areas of this habitat type were the playing fields at the NUIG Sporting Campus and the racetrack at the Galway Racecourse. Typical grass species included *Agrostis stolonifera*, *Agrostis capillaris*, *Cynosurus cristatus*, *Holcus lanatus* and *Lolium perenne*, along with the following herb species: *Bellis perennis*, *Cirsium arvense*, *Cirsium palustre*, *Cirsium vulgare*, *Plantago lanceolata*, *Plantago major*, *Potentilla anserina*, *Ranunculus repens*, *Rumex crispus*, *Rumex obtusifolius*, *Senecio jacobaea*, *Sonchus asper*, *Taraxacum officinale* agg. and *Trifolium pratense*.

8.3.4.22 Marsh (GM1)

The two small marsh areas at Na Foraí Maola Thoir (Ch. 1+100) were characterised by *Filipendula ulmaria*, *Lythrum salicaria*, *Juncus effusus* with *Ranunculus acris*, *Potentilla anserina*, *Mentha aquatica*, *Typha latifolia*, *Scrophularia auriculata* and *Angelica sylvestris* also present.

There was a small area of marsh habitat at Ballard West (Ch. 3+100). Typical marsh species such as *Lythrum salicaria*, *Mentha aquatica*, *Potentilla palustris*, *Myosotis scorpioides*, and *Hydrocotyle vulgaris* were present along with *Juncus articulatus*, *Carex panicea*, *Ranunculus acris*, *Leontodon autumnalis*, *Solidago virgaurea* and *Hypericum perforatum*.

To the north of Bearna Woods (c.55m east of the proposed development boundary at Ch. 3+900) there was a marsh near the east bank of the Tonabrocky Stream.

Species present included *Holcus lanatus*, *Festuca rubra*, *Molinia caerulea*, *Anthoxanthum odoratum*, *Filipendula ulmaria*, *Angelica sylvestris*, *Lythrum salicaria*, *Carex disticha*, *Carex nigra*, *Equisetum fluviatile*, *Valeriana officinalis*, *Potentilla palustris*, *Potentilla erecta*, *Calliergonella cuspidata* and *Juncus acutiflorus*.

The marsh area near the Rahoon Road Junction (west of Ch. 1+900 along the N59 Link Road South) was characterised by the following species: *Juncus effusus*, *Hydrocotyle vulgaris*, *Juncus acutiflorus*, *Agrostis stolonifera*, *Epilobium hirsutum*, *Typha latifolia*, *Epilobium palustre*, *Lotus pedunculatus*, *Filipendula ulmaria*, *Calliergonella* sp.

The marsh area at Castlegar (Ch. 13+000) is characterised by the following species: *Juncus acutiflorus*, *Agrostis stolonifera*, *Galium palustre*, *Carex nigra*, *Mentha aquatica*, *Comarum palustre*, *Calliergonella cuspidata*, *Epilobium palustre* and *Potentilla anserina*. Locally there is *Carex disticha*, *Carex panicea*, *Carex echinata* and *Carex rostrata* while *Cirsium palustre* is frequent throughout. Other species include *Juncus effusus, Luzula campestris, Menyanthes trifoliata, Hypericum tetrapterum, Filipendula ulmaria, Carex hirta, Molinia caerulea, Salix aurita, Anthoxanthum odoratum, Hydrocotyle vulgaris, Persicaria amphibia, Eleocharis palustris, Glyceria fluitans, Apium nodiflorum, and Ranunculus repens.* At the edges *Centaurea nigra*, *Briza media*, *Knautia arvensis*, *Leucanthemum vulgare* and *Ilex aquifolium* occurred.

8.3.4.23 Dry calcareous and neutral grassland (GS1)

There were scattered patches of neutral grassland present along the route of the proposed road development to the east of the River Corrib, generally associated with agricultural lands that are not intensively managed and subject to low intensity grazing. Typical grass species recorded included *Agrostis stolonifera*, *Agrostis capillaris*, *Holcus lanatus*, *Cynosurus cristatus*, *Anthoxanthum odoratum*, *Lolium perenne* and *Dactylis glomerata*. Herb species included *Achillea millefolium*, *Centaurea nigra*, *Prunella vulgaris*, *Lotus corniculatus*, *Trifolium repens*, *Trifolium pratense*, *Rumex acetosa*, *Urtica dioica*, *Senecio jacobaea*, *Ranunculus repens*, *Prunella vulgaris*, *Plantago lanceolata* and *Taraxacum officinalis* agg.

Given the underlying geology east of the River Corrib, this habitat was much more widespread to the east of the river and this was reflected in the greater species diversity, and in particular calcicole species, recorded.

The majority of calcareous grassland areas did not correspond with the Annex I habitat type *Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)* [*6210/6210], due the lack of sufficient indicator species in the sward. Typical species recorded included *Cynosurus cristatus*, *Holcus lanatus*, *Festuca rubra*, *Dactylis glomerata*, *Agrostis stolonifera*, *Lolium perenne*, *Daucus carota*, *Lotus corniculatus*, *Galium verum*, *Linum catharticum*, *Centaurea nigra*, *Plantago lanceolata*, *Cirsium arvense*, *Senecio jacobaea*, *Prunella vulgaris*, *Trifolium repens*, *Ranunculus acris*, *Trifolium pratense* and *Taraxacum officinale* agg.

In many areas the calcareous grasslands did correspond with the Annex I Calcareous grassland habitat type due to the presence of sufficient high quality positive/positive indicator species (after O'Neill *et al.*, 2013). High quality indicator species recorded in Calcareous grassland within the ZoI of the proposed road development included *Antennaria dioica*, *Anthyllis vulneraria*, *Asperula cynanchica*, *Briza media*, *Campanula rotundifolia*, *Carex caryophyllea*, *Carlina vulgaris*, *Koeleria macrantha* and *Linum catharticum*. Positive indicator species recorded included *Carex flacca*, *Ctenidium molluscum*, *Daucus carota*, *Galium verum*, *Helictotrichon pubescens*, *Leontodon hispidus*, *Lotus corniculatus*, *Pilosella officinarum*, *Ranunculus bulbosus*, *Sesleria caerulea*, *Thymus polytrichus* and *Trisetum flavescens*.

Within Lough Corrib cSAC, calcareous grassland was recorded at three locations within the ZoI of the proposed road development: on the east bank of the proposed River Corrib Bridge crossing (Ch. 9+400 – Ch. 9+475), along the spring/valley leading to the Coolough Lakes (Ch. 9+950), and to the north and west of Lackagh Quarry (Ch. 11+000 – Ch. 11+800) - see **Figure 8.14.7** and **Figure 8.14.8**.

On the east bank of the proposed River Corrib Bridge crossing the grassland was of the *Cynosurus cristatus – Trifolium repens* (3c) vegetation community (westernmost field) and the *Cynosurus cristatus – Trifolium pratense* (3d) vegetation community (easternmost field) and did not correspond with any Annex I habitat types. There was an area of the Annex I habitat type *Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)* [*6210/6210] to the south-east.

Along the spring/valley leading to the Coolough Lakes (the Lough Corrib cSAC boundary here is adjacent to the proposed road development) the grassland was of the *Holcus lanatus – Lolium perenne* grassland (2c) vegetation community and did not correspond with any Annex I habitat types.

Around the margins of Lackagh Quarry and west to Ch. 11+000, the grasslands were of the *Briza media – Thymus polytrichus* grassland (3a) vegetation community. In many cases, particularly to the north and west of the quarry boundary, the *Briza media – Thymus polytrichus* grassland corresponded with both the priority and non-priority classifications of the Annex I Calcareous grassland habitat type. The thin soils supported a highly diverse sward typically containing *Briza media*, *Carex flacca*, *Sesleria caerulea*, *Potentilla erecta*, *Succisa pratensis*, *Centaurea nigra*, *Galium verum* and *Leucanthemum vulgare*. Bryophytes include *Scleropodium purum* and *Ctenidium molluscum*.

The Calcareous grassland habitat within the ZoI of the proposed road development is summarised below in **Table 8.8** below.

Table 8.8: Areas of the Annex I habitat Calcareous grassland [*6210/6210] within the potential ZoI of the proposed road development

Area	Vegetation Community[27]
Within Lough Corrib cSAC c.27m south of the proposed road development along the east bank of the River Corrib	3a *Briza media – Thymus polytrichus* grassland [6210]
Within Lough Corrib cSAC c.20m south of the proposed road development between Ch. 11+050 and Ch. 11+150	3a *Briza media – Thymus polytrichus* grassland [6210]
Within Lough Corrib cSAC above the proposed Lackagh Tunnel (Ch. 11+300) and along the western and northern boundary of Lackagh Quarry between Ch. 11+000 and Ch. 11+800	3a *Briza media – Thymus polytrichus* grassland [*6210]
Adjacent to the proposed development boundary at Ch. 12+000	3a *Briza media – Thymus polytrichus* grassland [6210]
West of the N84 Headford Road Ch. 12+075 – Ch. 12+125	3a *Briza media – Thymus polytrichus* grassland [6210]
Along proposed development boundary at AR 12/02	3a *Briza media – Thymus polytrichus* grassland [6210]
Northern end of Coolagh Junction between Ch. 16+200 – Ch. 16+275	3a *Briza media – Thymus polytrichus* grassland [6210]
Adjacent to the south-western end of the Coolagh Junction	3a *Briza media – Thymus polytrichus* grassland [6210]
Adjacent to southern boundary of the Coolagh Junction	3a *Briza media – Thymus polytrichus* grassland [6210]

8.3.4.24 Dry meadows and grassy verges (GS2)

This habitat type was present across the study area and included abandoned agricultural fields, fields managed for silage/hay, neglected grassed areas associated with residential gardens or waste ground, and roadside verges.

Typical grass species included, *Arrhenatherum elatius*, *Dactylis glomerata*, *Holcus lanatus*, *Festuca rubra*, *Phleum pratense*, *Alopecurus pratensis*, *Agrostis stolonifera*, *Anthoxanthum odoratum* and *Lolium perenne*. Herb species recorded included *Centaurea nigra*, *Heracleum sphondylium*, *Calystegia sepium*, *Urtica dioica*, *Plantago lanceolata*, *Cirsium arvense*, *Ranunculus repens*, *Ranunculus acris*, *Rumex acetosa* subsp. *acetosa*, *Rumex obtusifolius*, *Cerastium fontanum*, *Potentilla anserina*, and *Scorzoneroides autumnalis*.

Across the eastern part of the scheme study area[28], in some instances this habitat type corresponded with the Annex I habitat *Lowland hay meadows (Alopecurus*

[27] The vegetation communities are assigned based upon the plant species recorded and with reference to the vegetation types described in *The Irish semi-natural grasslands survey 2007-2012. Irish Wildlife Manuals, No. 78* (O'Neill et al., 2013)
[28] Almost all occurrences of the 6510 Annex I habitat type were recorded east of the River Corrib.

pratensis, *Sanguisorba officinalis)* [6510]. However, none of these areas are within the ZoI of the proposed road development.

8.3.4.25 Dry-humid acid grassland (GS3)

Dry-humid acid grassland was recorded widely along the western part of the proposed road development in less intensively managed agricultural fields, often on the margins of peatland/heath sites, and frequently in a mosaic with wet grassland. In many cases, the grasslands were noted as being species poor as a result of grazing. Characteristic species included: the grasses, *Agrostis capillaris*, *Cynosurus cristatus*, *Anthoxanthum odoratum*, *Lolium perenne*, *Nardus stricta* and *Festuca rubra*; herb species such as *Rumex acetosa*, *Succisa pratensis*, *Potentilla erecta*, *Galium saxatile*, *Veronica officinalis*, *Achillea millefolium*, *Trifolium pratense* and *Juncus articulatus*; and moss species such as *Hylocomium splendens*, *Hypnum cupressiforme*, *Rhytidiadelphus squarrosus* and *Pleurozium schreberi*. Of note was the record of *Botrychium lunaria*, a species listed as Near Threatened on the Irish Red List for Vascular Plants (Jackson et al., 2016) from Knocknabrona/Knocknafroska in 2015, in an area outside of the proposed development boundary.

At one location in the scheme study area – Carrach, between Bearna Village and Bearna Woods – Dry-humid acid grassland corresponded with the priority Annex I habitat type *Species-rich Nardus grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe)* [*6230]. However, this area is not within the ZoI of the proposed road development.

8.3.4.26 Wet grassland (GS4)

Wet grassland was recorded across the scheme study area but more frequently west of Ballindooley Lough. It ranged in quality from species poor variants associated with lands managed for agriculture through to more diverse and species rich areas associated with the River Corrib/Coolagh Lakes and at Ballindooley Lough.

In the vicinity of the proposed road development, the more improved wet grassland fields, managed for agriculture, generally comprised rush species such as *Juncus effusus*, *Juncus articulatus* and *Juncus conglomeratus*, grass species including *Agrostis stolonifera*, *Arrhenatherum elatius*, *Holcus lanatus*, and *Lolium perenne*, and with fewer wet grassland herb species present than more semi-natural areas. Herb species recorded in wet grassland included *Angelica sylvestris*, *Carex flacca*, *Carex panicea*, *Cirsium palustre*, *Filipendula ulmaria*, *Galium palustre*, *Hydrocotyle vulgaris*, *Iris pseudacorus*, *Lotus pedunculatus*, *Lythrum salicaria*, *Mentha aquatica*, *Potentilla anserina*, *Potentilla erecta*, *Ranunculus acris*, *Ranunculus repens*, *Ranunculus flammula*, *Stachys palustris* and *Succisa pratensis*. Typical moss species included *Calliergonella cuspidata* and *Rhytidiadelphus squarrosus*.

A wet grassland type, dominated by *Molinia caerulea*, was also recorded in the western part of the scheme study area and was associated with the margins of some of the peatland areas in the vicinity of the proposed road development – at Na Foraí Maola Thiar (at Ar 0/04), at Troscaigh Thiar (Ch. 2+350) and at

Knocknabrona/Knocknafroska (Ch. 7+750). These grasslands corresponded with the 1d *Molinia caerulea – Potentilla erecta* grassland vegetation community (O'Neill et al., 2013). At the Foraí Maola Thiar site, *Potentilla erecta*, *Succisa pratensis*, *Anthoxanthum odoratum*, *Ranunculus acris*, *Ranunculus repens*, *Cirsium vulgare* and *Vicia sepium* were present in the sward but in low amounts. At Troscaigh Thiar, *Juncus acutiflorus* was abundant in the sward with *Sphagnum fallax*, *Succisa pratensis*, *Hylocomium splendens*, *Potentilla erecta*, *Anthoxanthum odoratum*, *Rhytidiadelphus loreus*, *Thuidium* sp., *Rumex acetosa* and *Calluna vulgaris* (rare) also present. At Knocknabrona/Knocknafrosca, Juncus acutiflorus, Sphagnum fallax, Carex panicea, Potentilla erecta, Succisa pratensis, Erica tetralix (rare), Lythrum salicaria and Calluna vulgaris (rare) were also present.

At two locations within the footprint of the proposed road development – at Na Foraí Maola Thiar and Ballindooley Lough – wet grassland corresponded with the Annex I habitat type *Molinia meadows on calcareous, peaty or clayey-silt laden soils (Molinion caeruleae)* [6410]. There was also an area of *Molinia* meadow habitat adjacent to the proposed development boundary at Ch. 3+800.

At Na Foraí Maola, the *Molinia* meadow was characterised by the following indicator species for this Annex I habitat type: *Juncus conglomeratus*, *Carex echinata*, *Carex flacca*, *Filipendula ulmaria*, *Galium palustre*, *Juncus articulatus*, *Lotus pedunculatus*, *Molinia caerulea*, *Potentilla erecta* and *Mentha aquatica*.

Ballindooley Lough is surrounded by a band of wet grassland which corresponds with the *Molinia* meadow Annex I habitat type. The vegetation was characterised by the high-quality positive/positive indicator species *Carex pulicaris*, *Cirsium dissectum*, *Achillea ptarmica*, *Carex echinata*, *Carex panicea*, *Carex nigra*, *Filipendula ulmaria*, *Juncus articulatus*, *Molinia caerulea* and *Potentilla erecta*. *Calliergonella cuspidata* was the main bryophyte species, but *Climacium dendroides and Rhytidiadelphus squarrosus* were also recorded towards the grazed habitat edges. At the edges of the wet meadows, where *Molinia caerulea* was very sparse or absent, other species occurring more frequently included *Potentilla anserina*, *Carex nigra*, *Holcus lanatus*, *Ranunculus repens*, *Galium palustre*, *Festuca arundinacea* and *Eleocharis palustris*. In these areas the grassland did not correspond to the Annex I habitat type. It was noted that the lack of grazing at the southern end has resulted in patches of *Molinia caerulea* becoming very tussocky and the habitat less species diverse. Drainage and drying out of the peat is also likely to be affecting the habitat composition around the lake to a degree.

The *Molinia* meadow habitat within the ZoI of the proposed road development is summarised below in **Table 8.9**.

Table 8.9: Areas of the Annex I habitat *Molinia* meadow [6410] within the potential ZoI of the proposed road development

Area	Vegetation Community[29]
Na Foraí Maola Thiar at Ch. 0+900	1c *Molinia caerulea – Succisa pratensis* grassland
North of Bearna Woods Ch. 3+800	1c *Molinia caerulea – Succisa pratensis* grassland
Ballindooley Lough Ch. 12+250 – Ch. 12+400	1d *Molinia caerulea – Potentilla erecta* grassland

8.3.4.27 Dense bracken (HD1)

This habitat type was most prevalent along the western part of the proposed road development, associated with *Pteridium aquilinum* dominating abandoned agricultural fields (in conjunction with bramble cover in many instances), the margins of less intensively managed agricultural fields, and around the edges of peatland sites in conjunction with dense gorse cover.

8.3.4.28 Dry siliceous heath (HH1)

Patches of dry siliceous heath were present all along the route of the proposed road development to the west of the N59 Moycullen Road, generally relatively small in area, and most often in association with, or forming mosaics with, wet heath, bog and acid grassland. All areas of dry heath vegetation communities recorded within the ZoI of the proposed road development corresponded with the *Ulex gallii - Erica cinerea* dry heath (DH1) vegetation community, characterised by the presence of *Ulex gallii* along with *Erica cinerea* or *Calluna vulgaris*.

Typical dry heath species recorded included the vascular plant species *Ulex gallii*, *Calluna vulgaris*, *Erica cinerea*, *Molinia caerulea*, *Daboecia cantabrica*, *Potentilla erecta*, *Arctostaphylos uva-ursi*, *Pteridium aquilinum*, *Carex binervis*, *Carex panacea*, *Carex echinata*, along with the moss species *Rhytidiadelphus squarrosus*, *Hypnum cupressiforme*, *Hypnum jutlandicum*, and *Pseudoscleropodium purum*, and the lichen *Cladonia* cf *portentosa*. Other species recorded included *Agrostis capillaris*, *Succisa pratensis*, *Teucrium scorodonia*, *Hylocomium splendens*, *Solidago virgaurea*, *Viola* sp., *Dicranum scoparium* and *Campylopus introflexus*.

All instances of dry siliceous heath corresponded with the Annex I habitat type *European dry heaths* [4030]. The siliceous Dry heath habitat within the ZoI of the proposed is summarised below in **Table 8.10**.

[29] The vegetation communities are assigned based upon the plant species recorded and with reference to the vegetation types described in *The Irish semi-natural grasslands survey 2007-2012. Irish Wildlife Manuals, No. 78* (O’Neill et al., 2013)

Table 8.10: Areas of the siliceous variant of the Annex I habitat Dry heath [4030] within the potential ZoI of the proposed road development

Area	Vegetation Community30
Bearna West Roundabout/R336 between Ch. 0+000 and Ch. 0+050	DH1 *Ulex gallii* - Erica cinerea dry heath
North of Bearna West Roundabout between Ch. 0+175 and Ch. 0+450	DH1 *Ulex gallii* - Erica cinerea dry heath
Na Foraí Maola Thiar between Ch. 0+625 and Ch. 0+700	DH1 *Ulex gallii* - Erica cinerea dry heath
Na Foraí Maola Thiar between Ch. 0+900 and Ch. 1+000	DH1 *Ulex gallii* - Erica cinerea dry heath
Na Foraí Maola Thiar at Ch. 1+075	DH1 *Ulex gallii* - Erica cinerea dry heath
Na Foraí Maola Thoir between Ch. 1+175 and Ch. 1+550	DH1 *Ulex gallii* - Erica cinerea dry heath
Troscaigh Thiar between Ch. 1+700 and Ch. 2+400	DH1 *Ulex gallii* - Erica cinerea dry heath
Ballard East between Ch. 3+450 and Ch. 3+550	DH1 *Ulex gallii* - Erica cinerea dry heath
Ballard East between Ch. 3+750 and Ch. 3+850	DH1 *Ulex gallii* - Erica cinerea dry heath
Cappagh between Ch. 4+725 and Ch. 5+250	DH1 *Ulex gallii* - Erica cinerea dry heath
N59 Link Road North between Ch. 0+550 and Ch. 0+600	DH1 *Ulex gallii* - Erica cinerea dry heath
Knocknafroska between Ch. 7+800 and Ch. 7+975	DH1 *Ulex gallii* - Erica cinerea dry heath

8.3.4.29 Dry calcareous heath (HH2)

Dry calcareous heath was recorded in the Menlough/Coolough area; sometimes in larger distinct habitat patches but most often in a mosaic with outcropping limestone, scrub and/or calcareous grassland. The two larger areas were to the north of An Seanbóthar and on higher ground near to the eastern shore of the northernmost of the Coolagh Lakes. Typical plant species recorded included the vascular plants *Calluna vulgaris*, *Molinia caerulea*, *Sesleria caerulea*, *Rubus fruticosus* agg., *Carex panicea*, *Carex flacca*, *Carex pulicaris*, *Succisa pratensis*, *Rosa spinosissima*, *Potentilla erecta*, *Hedera helix*, and mosses such as *Thuidium tamariscinum*, *Breutelia chrysocoma* and *Scleropodium purum*.

This habitat corresponded with the *Calluna vulgaris – Antennaria dioica* dry heath (DH5) vegetation community of the Annex I habitat type *European dry heaths* [4030]. The calcareous Dry heath habitat within the ZoI of the proposed road development is summarised below in **Table 8.11**.

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[30] The vegetation communities are assigned based upon the plant species recorded and with reference to the vegetation types described in *Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. Irish Wildlife Manuals, No. 79* (Perrin et al., 2014)

Table 8.11: Areas of the calcareous variant of the Annex I habitat Dry heath [4030] within the potential ZoI of the proposed road development

Area	Vegetation Community
North of Seanbóthar between Ch. 10+450 and Ch. 10+650	DH5 *Calluna vulgaris – Antennaria dioica* dry heath
Coolagh Lakes	DH5 *Calluna vulgaris – Antennaria dioica* dry heath

8.3.4.30 Wet heath (HH3)

Wet heath occurred predominantly across the western part of the scheme study area; with only a few small patches of this habitat type present east of the River Corrib around the margins of the Coolagh Lakes. Typical vascular plant species in those areas in the vicinity of the proposed road development included *Calluna vulgaris*, *Erica tetralix*, *Schoenus nigricans*, *Trichophorum germanicum*, *Ulex gallii*, *Eriophorum angustifolium*, *Eriophorum vaginatum*, *Myrica gale*, *Potentilla erecta*, *Succisa pratensis* and *Juncus articulatus*. Typical moss species recorded included *Cladonia* cf *portentosa*, *Hylocomium splendens*, *Sphagnum capillifolium* subsp. *rubellum*, *Sphagnum cuspidatum*, *Sphagnum denticulatum*, *Sphagnum tenellum*, *Pleurozia purpurea*, *Sphagnum compactum* and *Diplophyllum albicans*.

In all cases this habitat corresponded with the Annex I habitat type *Northern Atlantic wet heaths with Erica tetralix* [4010]. The Wet heath habitat within the ZoI of the proposed road development is summarised below in **Table 8.12**.

Table 8.12: Areas of the Annex I habitat Wet heath [4010] within the potential ZoI of the proposed road development

Area	Vegetation Community[31]
Na Foraí Maola Thiar between Ch. 0+600 and Ch. 0+700	WH7 *Molinia caerulea – Ulex gallii* wet heath
Na Foraí Maola Thoir between Ch. 0+900 and Ch. 1+400	WH3 *Calluna vulgaris - Molinia caerulea - Sphagnum capillifolium* wet/damp heath
Troscaigh Thiar – Ch. 1+850-Ch. 2+400	WH3 *Calluna vulgaris - Molinia caerulea - Sphagnum capillifolium* wet/damp heath
Ballard West – Ch .2+900 – Ch. 3+025	WH3 *Calluna vulgaris - Molinia caerulea - Sphagnum capillifolium* wet/damp heath
Ballard East – Ch. 3+450 – Ch. 3+825	WH3 *Calluna vulgaris - Molinia caerulea - Sphagnum capillifolium* wet/damp heath
Cappagh – Ch. 4+800 – Ch. 5+125	WH4b *Trichophorum germanicum- Eriophorum angustifolium* wet heath: *Calluna vulgaris* sub-community

[31] The vegetation communities are assigned based upon the plant species recorded and with reference to the vegetation types described in *Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. Irish Wildlife Manuals, No. 79* (Perrin et al., 2014)

Area	Vegetation Community[31]
Coolagh Lakes	WH6 *Schoenus nigricans – Molinia caerulea – Myrica gale* wet heath

8.3.4.31 Lowland blanket bog (PB3)

Lowland blanket bog was recorded across the western part of the scheme study area, to the north of the proposed road development. This habitat type was only recorded within the ZoI of the proposed road development at Na Foraí Maola Thiar (Ch. 0+650 – Ch. 0+750) where it formed a mosaic with wet heath, dry heath and scrub at the southern extent of a much larger peatland site within Moycullen Bogs NHA. Approximately 10% of this habitat area corresponded with the Lowland blanket bog classification; although this habitat type did not occur within the proposed development boundary.

Typical vascular plant species present included *Calluna vulgaris*, *Molinia caerulea*, *Schoenus nigricans*, *Rhynchospora alba*, *Erica tetralix*, *Carex panicea*, *Eriophorum angustifolium*, *Eriophorum vaginatum*, *Narthecium ossifragum*, *Trichophorum germanicum*, *Drosera rotundifolia* and *Potentilla erecta*. Typical moss species included *Sphagnum capillifolium* ssp. *rubellum*, *Sphagnum papillosum*, *Sphagnum tenellum*, *Sphagnum cuspidatum*, *Aulacomnium palustre* and *Odontoschisma sphagni*.

Lowland blanket bog habitat corresponded with the Annex I habitat type *Blanket bogs* [*7130]. The Blanket bog habitat within the ZoI of the proposed road development is summarised below in **Table 8.13** below.

Table 8.13: Areas of the Annex I habitat Blanket bog [*7130] within the potential ZoI of the proposed road development

Area	Vegetation Community[32]
Na Foraí Maola Thiar between Ch. 0+650 and Ch. 0+750	BB3 *Eriophorum vaginatum – Sphagnum papillosum* bog

8.3.4.32 Rich fen and flush (PF1)

There was a large Rich fen complex present at Kentfield with one of the fen areas immediately adjacent to the proposed drainage outfall for the N59 Link Road North. This fen polygon corresponded with the RFLU1a vegetation community (*Carex viridula oedocarpa - Pinguicula vulgaris - Juncus bulbosus* flush; brown moss sub-community) of the Annex I habitat type *Alkaline fens* [7230]. *Carex panicea* and *Carex viridula* were the most abundant plant species present with *Molinia caerulea*, *Juncus bulbosus* and *Succisa pratensis* also frequently recorded. Other species recorded included *Hydrocotyle vulgaris*, *Agrostis stolonifera*, *Anagallis tenella*,

[32] The vegetation communities are assigned based upon the plant species recorded and with reference to the vegetation types described in *Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. Irish Wildlife Manuals, No. 79* (Perrin et al., 2014)

Calliergonella cuspidata, *Carex flacca*, *Festuca rubra*, *Potentilla erecta*, *Prunella vulgaris*, *Anthoxanthum odoratum*, *Carex echinata* and *Drepanocladus cossonii*.

There were also areas of Rich fen amongst the fringing aquatic vegetation surrounding the Coolagh Lakes (along with a few isolated patches along the banks of the River Corrib, downstream of the proposed River Corrib Bridge) characterised by species such as: *Calliergonella cuspidata*, *Agrostis stolonifera*, *Carex nigra*, *Trifolium repens*, *Carex panicea*, *Potentilla anserina*, *Mentha aquatica*, *Festuca arundinacea*, *Filipendula ulmaria*, *Carex ovalis*, *Anthoxanthum odoratum*, *Cardamine pratensis*, *Epilobium palustre*, *Galium palustre*, *Juncus articulatus*, *Lythrum salicaria*, *Ranunculus flammula*, *Vicia cracca*, *Rhytidiadelphus squarrosus*, *Senecio aquaticus*, *Carex echinata* and *Equisetum fluviatile*. A number of these polygons corresponded with the RFEN1a vegetation community of the Annex I Alkaline fen habitat type due to the presence of the positive indicator species *Campylium stellatum*, *Carex panicea*, *Carex rostrata*, *Carex viridula s. brachyrrhyncha*, *Drepanocladus revolvens* and *Scorpidium scorpioides*[33]. Some Rich fen areas here corresponded with the priority Annex I habitat type *Calcareous fens with* Cladium *mariscus and species of the* Caricion davallianae [*7210], characterised by *Schoenus nigricans*, *Cladium mariscus*, *Campylium stellatum*, *Drepanocladus revolvens*, *Fissidens adianthoides*, *Molinia caerulea*, *Ctenidium molluscum*, *Filipendula ulmaria*, *Phragmites australis*, *Succisa pratensis* and *Carex panicea*.

At Ballindooley Lough, one of the areas of Rich fen corresponds with the RFLU4 vegetation community (*Schoenus nigricans – Scorpidium scorpioides* flush) of the Annex I Alkaline fen habitat type characterised by the following species: *Schoenus nigricans*, *Juncus subnodulosus*, *Molinia caerulea*, *Hydrocotyle vulgaris*, *Carex panacea*, *Carex lepidocarpa*, *Juncus articulatus*, *Ranunculus flammula*, *Cirsium dissectum*, *Parnassia palustris*, *Drosera anglica*, *Calliergonella cuspidata*, *Scorpidium scorpioides*, *Scorpidium cossonii*, *Campylium stellatum* and *Myrica gale*. Some fen areas here also corresponded with the priority Annex I habitat type *Calcareous fens with* Cladium *mariscus and species of the* Caricion davallianae [*7210]

The Alkaline fen and *Cladium* fen habitat within the ZoI of the proposed road development is summarised below in **Table 8.14**.

[33] Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. *Irish Wildlife Manuals, No. 79* (Perrin *et al.*, 2014)

Table 8.14: Areas of the Annex I habitat Alkaline fen [7230] and *Cladium* fen [*7210] within the potential ZoI of the proposed road development

Area	Vegetation Community
Kentfield, adjacent to drainage outfall	RFLU1a *Carex viridula oedocarpa - Pinguicula vulgaris - Juncus bulbosus* flush; brown moss sub-community [7230]
Coolagh Lakes	RFEN1a Carex rostrata fen; brown moss sub-community [7230] also *Cladium* fen [*7210]
Ballindooley Lough	RFLU4 *Schoenus nigricans – Scorpidium scorpioides* flush [7230] also *Cladium* fen [*7210]

8.3.4.33 Poor fen and flush (PF2)

There was an area of Poor fen at Na Foraí Maola Thiar (Ch. 0+700 – Ch. 0+800) characterised by the following species: *Juncus effusus*, *Juncus articulatus*, *Sphagnum denticulatum*, *Ranunculus flammula*, *Potamogeton polygonifolius*, *Juncus bulbosus*, *Philonotis fontana*, *Agrostis stolonifera*, *Lythrum salicaria*, *Calliergonella cuspidata* and *Sphagnum palustre*. This corresponded with the *Juncus effusus - Sphagnum cuspidatum/palustre* flush vegetation community (PFLU2). A second area to the north (near the proposed access track) was characterised by *Carex echinata*, *Juncus effusus*, *Juncus conglomeratus*, *Calliergonella cuspidata*, *Eriophorum angustifolium*, *Potentilla palustris*, *Angelica sylvestris*, *Sphagnum papillosum*, *Holcus lanatus*, *Anthoxanthum odoratum* and *Agrostis stolonifera*.

At Knocknafroska (Ch. 7+800 to Ch. 7+975) there were two areas of Poor fen recorded. The smaller area corresponded with the SW1 *Potamogeton polygonifolius* soakway vegetation community Other species present included *Sphagnum* spp., *Polytrichum commune*, *Carex panicea*, *Juncus effusus*, *Juncus bulbosus*, *Ranunculus flammula*, *Anagallis tenella*, *Menyanthes trifoliate* and *Hydrocotyle vulgaris*. The larger area to the north was heavily grazed and dominated by *Juncus effusus* with a layer of *Sphagnum* sp. underneath (including *Sphagnum palustre*). Other species recorded included *Calliergonella cuspidata*, *Holcus lanatus* and *Rumex acetosa*.

8.3.4.34 Residential

This non-Fossitt classification is used to represent residential properties along the proposed road development and generally consist of a mosaic of buildings and artificial surfaces (BL3), amenity grassland (GA2), flower beds and borders (BC4) and ornamental shrubs (WS3), with unmanaged rank grassland areas also occasionally present (GS2).

8.3.4.35 (Mixed) broadleaved woodland (WD1)

There were small stands of broadleaved woodland scattered along the route of the proposed road development from the western end of the proposed road development to the woodlands at Menlough. The largest area was at the NUIG Sporting Campus, where most of the woodland was planted for amenity purposes, and the woodlands at Menlough, which are long established (dating back to the 1800s).

At Na Foraí Maola Thiar (Ch. 0+800 – Ch. 1+000) there was a band of planted trees surrounding a residential garden which included *Acer pseudoplatanus*, *Fagus sylvatica*, *Quercus robur*, *Salix* sp., *Alnus cordata*, *Alnus glutinosa*, *Corylus avellana*, *Crataegus monogyna* and *Prunus* sp.

Along the eastern edge of the Na Foraí Maola Road was a stand of woodland comprising *Acer pseudoplatanus*, *Salix cinerea*, *Fagus sylvatica*, *Quercus robur*, *Alnus cordata*, *Alnus glutinosa*, *Sorbus aria*, *Lonicera periclymenum*, *Hedera helix*, *Dryopteris filix-mas*, *Urtica dioica*, *Blechnum spicant* and *Phyllitis scolopendrium*.

At An Chloch Scoilte Junction (Ch. 3+300 – Ch. 3+400) the woodland species comprised *Fraxinus excelsior*, *Acer pseudoplatanus*, *Rubus fruticosus agg*., *Phyllitis scolopendrium*, *Hedera helix*, *Heracleum sphondylium*, *Crataegus monogyna*, *Cotoneaster* sp., *Urtica dioica*, *Dryopteris filix-mas*, *Polypodium vulgare* and *Symphoricarpos albus*.

At the NUIG Sporting Campus (Ch. 8+725 – Ch. 9+250) there were many stands of maturing amenity broadleaved woodland planting including tree species such as *Acer pseudoplatanus*, *Fraxinus excelsior*, *Fagus sylvatica*, *Tilia cordata*, *Aesculus hippocastanum* and *Ulmus glabra*. The field layer contained species such as *Hedera helix*, *Geum urbanum*, *Vicia sepia*, *Torilis japonica*, *Rubus fruticosus agg*., *Arrhenatherum elatius* and *Brachypodium sylvaticum*.

There were two areas of mixed broadleaved woodland within the boundary of Lough Corrib cSAC, on the eastern bank of the River Corrib (Ch. 9+475 – Ch. 9+650). The main species that made up the woodland flora in the main block were *Fagus sylvatica*, *Fraxinus excelsior*, *Ilex aquifolium* and *Thamnobryum alopecurum*. Also recorded were *Arum maculatum*, *Hedera helix*, *Isothecium alopecuroides*, *Kindbergia praelonga*, *Neckera complanata*, *Radula complanata*, *Lejeunea cavifolia*, *Metzgeria furcata*, *Rhynchostegiella tenella* and *Tortella tortuosa*. The narrow linear strip to the east, at Ch. 9+500, was comprised of *Fagus sylvatica* with an *Ilex aquifolium* understory.

The linear strips of woodland at the City East Business Park Junction comprised *Fraxinus excelsior*, *Acer pseudoplatanus*, *Fagus sylvatica*, *Rubus fruticosus agg*. and *Urtica dioica*.

8.3.4.36 Mixed broadleaved/conifer woodland (WD2)

At the Troscaigh Road L5387 (Ch. 1+550 – Ch. 1+650) there was an area of planted broadleaved/conifer woodland associated with the residential properties. Tree species included *Acer pseudoplatanus*, *Fraxinus excelsior*, *Betula* sp., *Prunus* sp., *Pinus* sp., *Cupressus* sp. and *Rhododendron ponticum*.

A second small area of mixed broadleaved/conifer was present adjacent to the proposed road development at School Road in Castlegar (Ch. 13+150).

8.3.4.37 (Mixed) conifer woodland (WD3)

At the Troscaigh Road L5387 (Ch. 1+550 – Ch. 1+600) there was a small stand of *Pinus* sp. and *Cupressus* sp. mixed conifer woodland; *Rhododendron ponticum*, a non-native invasive plant species listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations, 2011, was also present here.

In a field south of the N59 Moycullen Road (Ch. 8+500) there was a small mixed *Picea* sp. conifer stand.

8.3.4.38 Hedgerows (WL1)

Along the western part of the proposed road development, hedgerow features not associated with residential properties were scarce as most field boundaries were stone walls or formed the edge of larger scrub patches. Many of the hedgerows recorded were over grown stone walls dominated by *Rubus fruticosus* agg. The hedgerows here were generally quite species poor. Typical species included *Prunus spinosa*, *Crataegus monogyna*, *Fraxinus excelsior*, *Rubus fruticosus* agg., *Urtica dioica*, *Hedera helix*, *Calystegia sepium*, *Pteridium aquilinum*, *Lonicera periclymenum*, *Epilobium hirsutum*, *Filipendula ulmaria*, *Germanium robertianum* and *Phyllitis scolopendrium*.

Hedgerows were much more abundant along the eastern part of the proposed road development and included some older more mature hedges. Hedgerows here were often associated with stone walls and where associated with agricultural fields were often dominated by Rubus fruticosus agg. *Crataegus monogyna*, *Prunus spinosa*, *Hedera helix* and *Rubus fruticosus* agg. were the most abundant hedgerow species recorded. Other common species included *Ilex aquifolium*, *Fraxinus excelsior*, *Salix cinerea*, *Corylus avellana*, *Urtica dioica*, *Calystegia sepium*, *Lonicera periclymenum*, *Pteridium aquilinum*, *Lathyrus pratensis* and *Rosa canina*; and *Sorbus aria*, *Viburnum opulus*, *Euonymus europaeus*, *Salix caprea* and *Quercus robur* were recorded occasionally.

8.3.4.39 Treelines (WL2)

Along the western part of the proposed road development, treelines were generally scarce and where present the majority were associated with planting along residential property boundaries. Tree species included *Fraxinus excelsior*, *Acer pseudoplatanus*, *Alnus glutinosa*, *Alnus cordata*, *Populus* sp., *Cupressus* sp., *Pinus* sp. (including *Pinus contorta*), *Picea sitchensis*, *Sorbus aucuparia* and *Fagus sylvatica*.

Treelines were also recorded along the eastern part of the proposed road development but much less frequently, as most field boundaries consisted of stone walls or hedgerows.

8.3.4.40 Oak-ash-hazel woodland (WN2)

The majority of oak-ash-hazel woodland was recorded along the eastern part of the proposed road development, with the most extensive area present between the River Corrib and Lackagh Quarry and large areas also recorded adjacent to the proposed road development (Ch. 13+200 – Ch. 13+900), south of the Roadstone Quarry. Many woodland blocks were small and isolated outside of these areas with only a few patches of oak-ash-hazel woodland recorded along the western part of the proposed road development, including areas of amenity planting at the NUIG Sporting Campus.

Along with *Fraxinus excelsior* and *Corylus avellana*, woody species recorded in these woodlands included *Euonymus europaeus*, *Crataegus monogyna*, *Prunus spinosa*, *Ilex aquifolium*, *Sorbus aria* agg., *Sorbus aucuparia*, *Quercus robur*, *Populus tremula*, *Hedera helix*, *Lonicera periclymenum*, and *Rubus fruticosus* agg. The field layer contained species such as *Fragaria vesca*, *Circaea lutetiana*, *Geranium robertianum*, *Potentilla sterilis*, *Sesleria caerulea*, *Primula vulgaris*, *Geum urbanum*, *Rumex sanguineus*, *Viola* spp., *Phyllitis scolopendrium* and *Arum maculatum*.

The wooded variant of the priority Annex I habitat Limestone pavement [*8240] was recorded in some woodland areas. Wooded Limestone pavement were those areas having a closed canopy of trees at least 3m tall with at least 50% of the surface comprising bedrock at the surface (the bedrock was normally covered by mosses) and retaining some evidence of limestone pavement structure. In the [*8240] wooded limestone pavement habitats encountered, soil was generally present but was thin (< 2cm), though could be deeper in places, for example, in old grykes, due to a build-up of humus. Rocks were sometimes completely covered by bryophytes such as *Eurhynchium striatum*, *Neckera crispa* and *Thamnobryum alopecurum*, but soil was typically lacking underneath the moss growth. These areas often occurred in mosaic with non-Annex I WN2 woodland.

The wooded Limestone pavement habitat (LPW) within the ZoI of the proposed road development is summarised below in **Table 8.15**.

Table 8.15: Areas of the wooded variant of the Annex I habitat wooded Limestone pavement [*8240] within the potential ZoI of the proposed road development

Area	Vegetation Community[34]
Menlough between Ch. 9+840 and Ch. 9+900	LPW_2b *Fraxinus excelsior - Plagiomnium undulatum* woodland
Menlough at Ch. 9+975	LPW_2a *Corylus avellana - Ctenidium molluscum* low woodland
Within Lough Corrib cSAC Adjacent to the proposed road development between Ch. 9+950 and Ch. 10+050	LPW_2a *Corylus avellana - Ctenidium molluscum* low woodland
South of Bóthar Nua at Ch. 10+100	LPW_2a *Corylus avellana - Ctenidium molluscum* low woodland
Bóthar Nua to Seanbóthar between Ch. 10+150 and Ch. 10+500	LPW_2b *Fraxinus excelsior - Plagiomnium undulatum* woodland
Within Lough Corrib cSAC Along the proposed development boundary to the west and north of Lackagh Quarry between Ch. 10+800 and Ch. 11+800	LPW_2a *Corylus avellana - Ctenidium molluscum* low woodland LPW_2b *Fraxinus excelsior - Plagiomnium undulatum* woodland
Within/adjacent to the proposed road development between Ch. 13+200 and Ch. 13+550	LPW_2b *Fraxinus excelsior - Plagiomnium undulatum* woodland
Adjacent to the proposed development boundary between Ch. 13+800 and Ch. 13+875	LPW_2a *Corylus avellana - Ctenidium molluscum* low woodland
Coolagh Junction between Ch. 16+100 and Ch. 16+250	LPW_2a *Corylus avellana - Ctenidium molluscum* low woodland

8.3.4.41 Wet willow-alder-ash woodland (WN6)

Along the western bank of the River Corrib at the NUIG Sporting Campus (Ch. 9+275) there was a narrow linear band of *Salix cinerea* wet woodland (WN6-3c *Alnus glutinosa – Filipendula ulmaria* group, *Salix cinerea – Equisetum fluviatile* vegetation type). *Rubus fruticosus* agg. and *Centaurea nigra* were also prominent species in this section of woodland. This area of woodland did not correspond with the Residual alluvial forest [*91E0] Annex I habitat type. This was distinct from the large area of wet woodland (WN6_3e *Alnus glutinosa – Filipendula ulmaria* group, *Betula pubescens – Mentha aquatica* vegetation type) further downstream which corresponded with the priority Annex I habitat type *Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)* [*91E0].

A small patch of *Salix cinerea* wet woodland (WN6-3c *Alnus glutinosa – Filipendula ulmaria* group, *Salix cinerea – Equisetum fluviatile* vegetation type) was present within the proposed development boundary at Ch. 9+850 – Ch. 9+900;

[34] The vegetation communities are assigned based upon the plant species recorded and with reference to the vegetation types described in *National survey of limestone pavement and associated habitats in Ireland. Irish Wildlife Manuals, No. 73* (Wilson, S. and Fernández, F., 2013)

and immediately adjacent to the boundary of Lough Corrib cSAC. The woodland here corresponded with the Residual alluvial forest [*91E0] Annex I habitat type. The woodland was dominated by *Salix cinerea* subsp. *oleifolia*, with *Fraxinus excelsior*, *Agrostis stolonifera*, *Rubus fruticosus* agg., *Filipendula ulmaria* and *Eurhynchium striatum* recorded frequently. Other species present included: *Juncus effusus*, *Hedera helix*, *Lythrum salicaria*, *Galium palustre*, *Geranium robertianum*, *Crataegus monogyna*, *Prunus spinosa*, *Galium aparine*, *Rumex sanguineus*, *Equisetum fluviatile*, *Epilobium hirsutum*, *Corylus avellana*, *Ranunculus repens* and the moss species *Calliergonella cuspidatum*, *Eurhynchium striatum*, *Kindbergia praelonga* and *Thamnobryum alopecurum*.

The Residual alluvial forest habitat within the ZoI of the proposed road development is summarised below in **Table 8.16**.

Table 8.16: Areas of the Annex I habitat Residual alluvial forests [*91E0] within the potential ZoI of the proposed road development

Area	Vegetation Community[35]
Downstream of the proposed road development on west bank of River Corrib Ch. 9+250 – overlaps slightly with the south-eastern edge of the proposed development boundary	WN6-3c *Alnus glutinosa – Filipendula ulmaria* group, *Salix cinerea – Equisetum fluviatile* vegetation type
Adjacent to the proposed road development between Ch. 9+800 and Ch. 9+900	WN6-3c *Alnus glutinosa – Filipendula ulmaria* group, *Salix cinerea – Equisetum fluviatile* vegetation type

8.3.4.42 Scrub (WS1)

Patches of scrub were widespread along the proposed road development ranging in size from small isolated patches to larger expanses, where previously grazed land had been abandoned or where scrub is encroaching on semi-natural habitats. In the western part of the study area, the larger areas of scrub were generally associated with the margins of bog/heath areas where scrub is encroaching from adjoining low intensity or abandoned agricultural fields. Typical species (and in some cases the predominant species in some areas) were *Ulex europaeus*, *Prunus spinosa*, *Crataegus monogyna*, *Salix cinerea* and *Rubus fruticosus* agg. In the eastern part of the study area, the scrub was generally dominated by *Corylus avellana*, *Prunus spinosa* and/or *Crataegus monogyna*.

In some instances, polygons mapped as scrub corresponded with Annex I habitat types. In most cases the scrub is the dominant habitat in a mosaic with other Fossitt habitat types and it is those other habitats, not the scrub itself, that correspond with Annex I habitat types. As an example, scrub was often recorded in a mosaic with dry heath habitats which corresponded with the Annex I Dry heath habitat type but as scrub was dominant in the recorded polygon it was mapped as such. Where this

[35] The vegetation communities are assigned based upon the plant species recorded and with reference to the vegetation types described in *Results of monitoring survey of old sessile oak woods and alluvial forests. Irish Wildlife Manuals, No. 71* (O'Neill, F.H. & Barron, S.J., 2013)

was the case, these Annex I habitat areas are described under the appropriate sections – e.g. Dry heath [4130] is described under the *Dry siliceous heath (HH1)* heading above.

However, areas of limestone pavement that were being invaded by scrub (almost invariably *Corylus avellana*), where the scrub was not forming a continuous canopy and was less then 3m in height, corresponded with the exposed limestone pavement group (LPE) of the priority Annex I habitat type *Limestone pavements* [*8240]. The main vascular species include scattered low-growing woody species (e.g. *Rubus fruticosus*, *Rosa spinosissima*, *Hedera helix* or immature *Corylus avellana* or *Ilex aquifolium*) and herbaceous species like *Sesleria caerulea*, *Teucrium scorodonia*, *Mycelis muralis*, *Geranium robertianum*, *Senecio jacobaea*, *Carlina vulgaris* and *Carex flacca*. A suite of calcicole ferns is usually found comprising *Asplenium ruta-muraria*, *Ceterach officinarum* and, in the deeper clefts (grykes), the shade-loving *Phyllitis scolopendrium*. Characteristic bryophytes are *Ctenidium molluscum*, *Tortella tortuosa* and *Neckera crispa.*

The scrub covered Limestone pavement habitat within the ZoI of the proposed road development is summarised below in **Table 8.17**.

Table 8.17: Areas of the scrub covered variant of the Annex I habitat Limestone pavement [*8240] within the potential ZoI of the proposed road development

Area	Vegetation Community[36]
Within Lough Corrib cSAC Adjacent to the proposed road development between Ch. 10+000 and Ch. 10+050	LPE_1e *Corylus avellana - Neckera crispa* pavement
Within Lough Corrib cSAC Along the proposed development boundary to the west and north of Lackagh Quarry between Ch. 10+900 and Ch. 11+800	LPE_1e *Corylus avellana - Neckera crispa* pavement

8.3.4.43 Immature woodland (WS2)

There was one area of young planted *Alnus glutinosa* woodland near the Boleybeg Bóithrín (Ch. 4+650) that corresponded to this habitat type.

8.3.4.44 Ornamental/non-native shrub (WS3)

Areas of ornamental/non-native shrub were generally associated with amenity planting at residential properties, residential developments and areas infested with non-native invasive plant species such as *Fallopia japonica* (areas of invasive plant species are discussed in more detail below under the Non-Native Invasive Plant Species section).

[36] The vegetation communities are assigned based upon the plant species recorded and with reference to the vegetation types described in *National survey of limestone pavement and associated habitats in Ireland. Irish Wildlife Manuals, No. 73* (Wilson, S. and Fernández, F., 2013)

8.3.4.45 Recently-felled woodland (WS5)

There was one area of recently felled *Corylus avellana* woodland in close proximity to the proposed road development at Ballindooley (Ch. 12+450 – Ch. 12+500).

8.3.5 Rare and protected plant species

Slender cottongrass *Eriophorum gracile* was the only protected plant species recorded during the course of the habitat surveys. It was recorded at two locations: Tonabrocky Bog and in Coolanillaun. Its presence at Tonabrocky Bog is consistent with the findings of the desktop review; the location at Coolanillaun is a new record for the species. Neither location is within the ZoI of the proposed road development.

The Small white orchid *Pseudorchis albida* was not recorded at the Doughiska site during the habitat surveys in June of 2014.

Both of the above species are protected under the Flora (Protection) Order, 2015.

The presence of the Flora (Protection) Order, 2015 (FPO) listed bryophyte species Varnished hook-moss was confirmed at Gortachalla, 9.4km to the north of the scheme study area. This plant species is listed on Annex II of the Habitats Directive and listed as qualifying interest species of Lough Corrib cSAC.

Records of all rare or protected plant species known from the scheme study area, or recorded during the field surveys, are shown on **Figure 8.2.1**.

8.3.6 Non-native invasive plant species

There were three non-native invasive plant species listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations, 2011 present within, or in close proximity to, the proposed road development. The locations of these non-native invasive plant species are summarised below in **Table 8.18** and shown on **Figures 8.15.1** to **8.15.15**.

Table 8.18: Summary of Non-native Invasive Plant Species Listed in the Third Schedule of the Birds and Habitats Regulations 2011 Recorded along or adjacent to the Proposed Road Development

Common Name	Scientific Name	Location
Japanese knotweed	*Fallopia japonica*	Along farm track, south of proposed Bearna West Roundabout, adjacent to the proposed road development Along eastern side of the Troscaigh Road (L5387) at Ch. 1+575 In rough grassland field with scrub, south-east of Ch. 5+250 near Ballyburke, outside of the proposed development boundary Adjacent to residential property located c.70m east of

Common Name	Scientific Name	Location
		the proposed drainage outfall at Rahoon In area of recolonising bare ground, north of Bóthar Diarmuida Junction, within the proposed development boundary between Ch. 0+325 and Ch. 0+425 along the N59 Link Road South In area of recolonising bare ground, between Ch. 8+350 and Ch. 8+400, within the proposed development boundary In woodland/scrub, between Ch. 8+800 and Ch. 8+950 at the NUIG Sporting Campus, adjacent to the proposed development boundary Along the Coolough Road In residential garden, and on adjacent rough grassland areas, within the proposed development boundary between Ch. 12+200 and Ch. 12+375 at the N84 Headford Road Junction
Himalayan knotweed	*Persicaria wallichii*	c.80m (east) and c.135m (west) from the proposed road development between Knocknafroska and the N59 Moycullen Road
Rhododendron	*Rhododendron ponticum*	In woodland within the proposed development boundary along eastern side of the Troscaigh Road (L5387) Adjacent to residential property located c.90m east of the proposed drainage outfall at Rahoon

8.3.7 Mammals

8.3.7.1 Otter

Otter, and their breeding and resting places, are protected under the Wildlife Acts. Otter are also listed on Annex II and Annex IV of the EU Habitats Directive.

Evidence of Otter *Lutra lutra* activity was abundant and widespread along the River Corrib corridor and the south-eastern shore of Lough Corrib. Otter were also recorded in the catchment of the Bearna Stream and the Tonabrocky Stream. The desktop review found that Otter have been recorded along the River Corrib corridor between the coast and Lough Corrib, along the coastline from Bearna to Oranmore, and at Ballindooley Lough[37].

One potential Otter holts and eight Otter couch sites were recorded within the study area. The potential holt site, and the majority of the couch sites, were recorded at Coolanillaun, along the southern shore of Lough Corrib and along the east bank of the River Corrib. Couch sites were also recorded at the Coolagh Lakes and on Jordan’s Island. The status, description and distance from the proposed road development of each of these features are provided below in **Table 8.19**. The results of the Otter surveys are shown on **Figures 8.3.1** to **8.3.14**.

Table 8.19: Results of the Otter surveys – Otter holts and couches

Ref. No.	Feature	Status and description
H1	Couch site	Active couch site along river bank >1km from the proposed road development
H2	Couch site	Active couch site along river bank >1km from the proposed road development
H3	Couch site	Active couch site along river bank c.450m from the proposed road development
H4	Potential natal holt	Dense scrub patch with abundant Otter signs surrounding and in the vicinity, well-worn and used trails leading into scrub – evidence suggestive of juvenile Otter being present. >1km from the proposed road development
H5	Couch site	Active couch site along river bank >1km from the proposed road development
H6	Couch site	Active couch site along river bank >1km from the proposed road development
H7	Couch site	Active couch site along river bank >1km from the proposed road development

[37] At Ballindooley Lough, the mammal survey study area focussed on the southern section of this wetland complex (refer to **Figure 8.3.8** and **Figure 8.3.9**) and Otter were not recorded in this area during the survey.

Ref. No.	Feature	Status and description
H8	Couch site	Active couch site along river bank >1km from the proposed road development
H9	Couch site	Active couch site along river bank c.600m from the proposed road development

8.3.7.2 Bats

Bats, and their breeding and resting places, are protected under the Wildlife Acts. All bat species are also listed on Annex IV of the EU Habitats Directive; with the Lesser horseshoe bat also listed on Annex II.

Significant bat surveys were carried out in the preparation of this EIAR, and the results of these are set below. The results of these surveys are also presented in **Figures 8.4.1** to **8.4.2** and **Figures 8.17.1** to **8.22.1**.

Separate reports on the results of the radio-tracking studies undertaken in 2014 and 2015 are provided in **Appendix A.8.7**, **Appendix A.8.9** and **Appendix A.8.10**. A separate report on the full results of the static detector monitoring undertaken in 2014 are detailed in **Appendix A.8.8**.

The structure of this section is such that each bat species is described in turn. The results of the various surveys are presented to allow an understanding of each species in terms of its distribution across the scheme study area.

8.3.7.2.1 Lesser horseshoe bat Rhinolophus hipposideros

The results of the bat surveys as they relate to the Lesser horseshoe bat are shown on **Figure 8.18.1**.

Historical records

Prior to the commencement of the surveys to inform the Constraints and Route Selection Studies for the proposed road development, there were a small number of records of Lesser horseshoe bats from the scheme study area. They comprised records of the bat roosts at Menlo Castle, suspected night roosts at a barn in Menlough Village and two sheds in Coolough collected as part of the previous studies for the 2006 Galway City Outer Bypass (RPS, 2006). Menlo Castle has been regarded to be a key maternity colony for the area since it was found in August 2000 and has since been monitored annually by the NPWS. Ad-hoc observations during other bat surveys (e.g. BATLAS 2010) also noted Lesser horseshoe bat activity on the western side of the River Corrib at Dangan.

Surveys carried out for previous environmental assessments recorded Lesser horseshoe bats at NUIG (McCarthy, Keville and O’Sullivan, 2014a) and Killarainy near Moycullen (RPS, 2013a).

The general lack of historical roost records and ad-hoc observations for this species did not necessarily suggest their low density or absence from specific areas. It is more likely to have been due to both the lack of targeted surveys for this species and the tendency for it to be overlooked due to its very quiet and narrowly-focused echolocation calls, which allows it to be detected only at very close range.

Identification of locations used for winter hibernation

Unlike other Irish bat species, the Lesser horseshoe bat hibernates in the open, hanging from the ceiling of caves, cellars and other structures kept cool in winter. Therefore, it is much easier to find than other bat species at this time of year.

Following the collation of the historical data at the end of 2014, the examination of historical maps and records of caves and underground structures provided a list of locations that could be potential sites used for hibernation. **Figure 8.18.1** shows these locations. These included:

- Menlo Castle
- Merlin Castle
- Ballybrit Castle
- Roscam Round Tower
- Cooper's Cave
- Newry's Cave
- Dangan Ice House
- Souterrain in the townland of Lydican

The interior of Ballybrit Castle and Merlin Castle were inaccessible for the winter surveys that were undertaken in 2014 and therefore use of these castles by this species could not be ruled out. Evidence of Lesser horseshoe bats was only found in the rear of Cooper's Cave near Castlegar, where a small number of fresh droppings characteristic of this species were recorded, suggesting recent use.

Daytime visual inspections of accessible locations were also undertaken in February and March 2015. Six Lesser horseshoe bats were recorded within Cooper's Cave on the February 2015 visit. All bats were in a state of hibernation. It was noted that two of the bats were ringed. The ring numbers (which could be read without disturbing the bats) corresponded to the following bats ringed as part of the bat surveys in summer 2014: one was a male bat ringed and radio-tracked at Menlo Castle on the 30 August 2014; the other, a male bat ringed and radio-tracked at Cooper's Cave on the 1 September 2014. This confirmed that some of the individuals using the Menlo Castle summer roost also used the cave as a hibernation site, and that bats using Cooper's Cave in summer months also used the cave as a hibernation site.

Cooper's Cave was also checked again on 24 February 2016 and four Lesser Horseshoe bats were recorded in a state of hibernation. None of these bats were ringed. Surveys in January 2018 recorded six hibernating Lesser horseshoe bats present on the 8 January and three on the 11 January (including one ringed bat).

No bats were seen or otherwise recorded within Newry's Cave in Merlin Woods in 2015 and 2016. It became evident during visits in 2015 that this site floods via underground springs up to ceiling level and therefore would be unsuitable for hibernating bats.

Since Lesser horseshoe bats are known to travel outside their summer ranges to reach hibernation sites, it was necessary to examine similar potential hibernation sites outside of the scheme study area. Checks for bats (and particularly ringed bats) using other known underground sites were carried out in February 2015. Five Lesser horseshoe bats (not ringed) were found hibernating in Cloonnabinnia Cave, outside Moycullen. A large pile of Lesser horseshoe bat droppings were also found in Moycullen Cave suggesting that it is used as a roosting site but this may be used at other times of year. In 2018, winter surveys at Moycullen Cave and at Cloonnabinnia Cave recorded three Lesser horseshoe bats which were found hibernating at each location.

Attempts were made to gain access to land where the cave curiously named "Rhinolophus Retreat" is located; however, entry to lands was not possible. A souterrain near Athenry was also visited but found to be probably unsuitable for use by Lesser horseshoe bats as the entrance was blocked.

The results of the surveys of potential hibernation sites for this species of bat indicated that Cooper's Cave and Menlo Castle provide winter hibernation conditions, for several individuals, in the vicinity of the proposed road development. However, both sites are vulnerable to human disturbance or changes within the roosts due to rockfall. There is also the possibility that other concealed voids in limestone features could also host hibernating bats.

Identification of locations used in summer

Evidence of Lesser horseshoe bats was recorded at 15 structures, including Menlo Castle (PBR06) during the summer roost surveys in 2014 and 2015. Most roosts were located in the vicinity of Menlough and Castlegar. Outside these two areas, a day roost (PBR178) containing 9 bats, including 5 juvenile bats, was located in the garage of a house in the Aughnacurra residential estate, on the western side of the River Corrib, adjacent to the NUIG Sporting Campus. In August 2018, two counts were undertaken at this roost: twelve Lesser horseshoe bats were recorded on the first night, and ten on the second. Two of the lesser horseshoe bats present at the Aughnacurra roost on the 28 August 2018 were ringed, confirming the link between the roost sites at Menlo Castle, Cooper's cave and this satellite roost[38].

A night roost was also found in another garage in this estate (PBR210) (refer to **Figure 8.18.1** for these locations).

Other Lesser horseshoe bat roosts found on the western side of the city and surrounding environs included two night roosts in vicinity of Bearna Woods

[38] To the best of the author's knowledge, at the time of writing, the only Lesser horseshoe bat ringing programme undertaken locally in recent years was that undertaken in 2014 and 2015 as part of the N6 GCRR surveys, where bats captured at Menlo Castle and Cooper's Cave were ringed (see Appendix A.8.1, Section 1.4.9). Therefore, the ringed Lesser horseshoe bats observed at Aughnacurra are individuals ringed during the 2014/2015 studies at Menlo Castle and Cooper's Cave

(PBR124, PBR115), north of Bearna (PBR217) and a roost in the townland of Aubwee just off the N59 Moycullen Road to the north west of the city (PBR44). All "night roosts" were confirmed as such, when Lesser horseshoe bat droppings were recorded but the structure was deemed to be unsuitable as a day roost and no bats were seen in-situ.

On the eastern side of the city and surrounding environs, one Lesser horseshoe bat night roost (PBR21) was located adjacent to the Corinthian's Rugby Club off the N83 Tuam Road to the north east of the city, while a day roost with a single bat was found in a disused bungalow adjacent to Ballindooley Lough (PBR25).

Lesser horseshoe bats at Menlo Castle (PBR06) were monitored from 2006-2017 by the NPWS and more recently by surveyors from Scott Cawley Ltd. (see **Table 8.20** below for count results). Lesser horseshoe bats can be very difficult to count on emergence as they tend to fly in and out of the roost entrance. Monitoring of the roost in 2016, 2017 and 2018 used infra-red cameras and reflects the most accurate count for this roost.

Table 8.20: Numbers of Lesser Horseshoe bats recorded emerging from Menlo Castle

Date	Count	Source	Comments
16/06/2006	2	NPWS	-
24/06/2009	26	NPWS	-
07/07/2009	38	NPWS	-
29/6/2012	23	NPWS	-
02/07/2012	27	NPWS	-
13/06/2013	21	NPWS	-
04/06/2014	18	NPWS	-
18/06/2014	35	NPWS	-
29/06/2015	32	NPWS	-
29/06/2015	32	Scott Cawley Ltd	-
09/07/2015	29	NPWS	-
09/07/2015	29	Scott Cawley Ltd	Inclement weather
20/08/2015	28	NPWS	-
20/08/2015	28	Scott Cawley Ltd	Two bats did not emerge
29/08/2016	35	Scott Cawley Ltd	Counted from infra-red video camera footage. 2-3 bats may have remained in the roost.
11/08/2017	43	Scott Cawley Ltd	Counted from infra-red video camera footage. 1 bat exited from small chimney.
22/08/2018	20	Scott Cawley Ltd.	Counted from infra-red video camera footage.
27/08/2018	15	Scott Cawley Ltd.	Counted from infra-red video camera footage.

The roost numbers showed considerable variability in the counts but averaged 27 bats over the last ten years. This may be explained by bats using different (unknown) exit points on some nights, difficulties in counting in low light conditions, and weather conditions in preceding nights which may have forced some bats to use alternative roosts. Infra-red footage suggested that bats fly out at very low levels at high speeds and could have been easily overlooked by conventional emergence monitoring techniques.

Additional data on the roosts used by this species was collected during the radio-tracking in 2014 and 2015. Thirteen Lesser horseshoe bats were captured and fitted with radio-transmitters in the first radio-tracking session in August 2014. Ten of these (seven females and three males) were caught at the Menlo Castle roost (PBR06) and three (all males) were caught at Cooper’s Cave (PBR112). Five bats were captured and fitted with radio-transmitters in the September session; one (female) was caught in Menlough Woods and four (three males and one female) were captured at Cooper’s Cave (PBR112). The radio-tracking in August 2014 resulted in the identification of six day roosts and 11 night roosts for this species. Three of the six daytime roosts and seven of the 11 night roosts had already been identified as Lesser horseshoe roosts from the building inspections undertaken in 2014. Nine additional daytime roosts and eight additional night roosts were subsequently identified in the September 2014 session of radio-tracking. Only three roosts (Menlo Castle PBR06, Cooper’s cave PBR112 and a shed in Angliham Quarry PBR126) were used by bats during both tracking sessions. All roosts used by radio-tracked bats were located in the vicinity of Menlough Village, Coolough, Castlegar and Angliham Quarry.

To conclude, the surveys found Lesser horseshoe bats using several roosts in the daytime in summer including those consistently used such as Menlo Castle and Cooper’s Cave. Inspections of other structures and radio-tracking recorded other day roosts and a network of night roosts (**Figure 8.18.1**).

Eborhall House and Ballymaglancy Cave, located to the north of Lough Corrib, are both important roost sites for breeding and hibernating Lesser horseshoe bats respectively. Eborhall House is the “qualifying” roost for the Lough Corrib cSAC whilst the nearby Ballymaglancy Cave is a cSAC in its own right (No. 000474) and is thought to provide hibernation roosts for the bats from Eborhall House.

As part of the assessment of the potential movement of this bat species across the landscape, it was deemed important to determine if any of the ringed bats[39] that were roosting near the proposed road development were also using these “qualifying” roosts, even though they are located a considerable distance to the north (more than 30km).

Surveys were undertaken at Eborhall House and Ballymaglancy Cave to determine the presence of Lesser horseshoe bats that were ringed at roosts within the study area. These were undertaken under licence DER/BAT 2015-03, DER/BAT 2016-09, DER/BAT 2016-28 and DER/BAT 2017-06) on 21 October 2015, 23 August 2016 and 14 July 2017. Surveys in 2015 were undertaken by Paul Scott (Scott Cawley Ltd) with Mr John Higgins (NPWS Local Conservation Ranger) and in

[39] See the species accounts in this section for details on bats that were ringed.

2016 by Dr Daniel Buckley and in 2017 by Paul Scott. Daytime visual surveys were undertaken to count and identify any marked bats. Only the October 2015 surveys included Ballymaglancy Cave. No ringed bats from the study area were recorded during these visits.

Evidence of bat activity

This section summarises the results of the various surveys that recorded Lesser horseshoe bat activity across the scheme study area (**Figure 8.18.1**). Survey methods included vehicle transects, walked transects and use of static detectors at fixed locations in 2014 and 2015 covering both summer, autumn and winter seasons. The results of the radio-tracking are also summarised separately in this section.

Lesser horseshoe bats were not recorded during the vehicle transect surveys but would not normally be expected to be easily detected using that survey methodology, due to their quiet and directional echolocation calls. However, the walked transect surveys recorded this species at Menlo Castle and Cooper's Cave. Static bat detectors deployed during the walked transects recorded them by a culvert on the existing N6 (where the Terryland River flows under the road), by the Coolagh Lakes and by Ballindooley Lough.

The static bat detectors deployed in 2014 (**Figure 8.4.1**, **Figure 8.4.2** and **Figure 8.22.1**), recorded Lesser horseshoe bats at 14 locations. Sites S5, S6 and S21 recorded the highest amount of activity for this species, which was not surprising as these locations are all in close proximity to Menlo Castle (see summary of radio-tracking studies below). Beyond the Menlough area, Lesser horseshoe bats were also recorded at a woodland edge in the Ballindooley area (S2), close to a known roost identified during the building surveys, in the hazel scrub-limestone pavement complex east of Menlough (S4 and S22), within the grounds of Glenlo Abbey Hotel (S8), in Castlegar Valley (S10), on three sites on the north western edge of Galway City (S11, S13 and S15), the outskirts of Bearna Village (S19), and two sites on the north eastern edge of Galway City just to the north of Galway Technology Park (S1, S24).

The static detectors deployed in 2015 along the route of the proposed road development (at that time) recorded Lesser horseshoe bats at 15 locations. Activity was recorded within the known foraging area of the Menlough roost as suggested by the radio-tracking results (see below), including along the woodland edges, south of Menlo Castle, within the limestone pavement area between Menlough and the N84 Headford Road, Lackagh Quarry and on field boundaries north of Castlegar Village, into the area south of Castlegar Village where Cooper's Cave is located.

Lesser horseshoe bat activity was also recorded within the grounds of NUIG, east of Galway Racecourse and on the Bearna Stream, north of Bearna Woods.

For the crossing point surveys, possible recordings of Lesser horseshoe bats that were made on both microphones, that could suggest bats flying across the proposed road development, were recorded at two sites for Lesser horseshoe bat: CP7 and CP9. CP7 had one potential crossing record, while CP10 had 35 potential crossing records.

Monitoring of bat activity at Cooper's Cave, Newry's Cave and the City Centre Railway Tunnel took place in the autumn of 2014 and late winter in 2015. A small number of Lesser horseshoe bat calls were recorded on the 26 and 28 September 2014 in Newry's Cave. A large number of Lesser horseshoe bat calls were recorded throughout September 2014 and October 2014 in Cooper's Cave, which would suggest that Cooper's Cave is used in the mating season by this species. Lesser horseshoe bat activity was recorded at Cooper's Cave and Menlo Castle but not at any of the other locations during the late winter activity seasons in 2015. Therefore, based on these activity surveys it was concluded that Lesser horseshoe bats use Menlo Castle and Cooper's Cave throughout the year – Menlo Castle for breeding and hibernation and Cooper's Cave for mating and hibernation.

The radio-tracking surveys allowed the patterns of foraging and flight paths to be identified for this species. In August 2014, the maximum foraging distance from Menlo Castle ranged from 0.59km up to 5.15km, with the average maximum distance of foraging area from the roost being 2.93km. On average, males foraged slightly further afield, with the average maximum distance from the roost 3.68km, while females averaged a maximum distance of 2.29km.

In September 2014, the maximum foraging distance from the roost ranged from 1.11km up to 4.4km with the average maximum distance of foraging from the roost being 3.39km. On average, males foraged a maximum distance from the roost of 2.88km, while females averaged a maximum distance of 4.16km.

The overall foraging area in August 2014 comprised 21.75km^2 (MCP[40]) or 13.7km^2 (MLP[41]), whilst it was 56.10km^2 (MCP) or 26.46km^2 (MLP) in September 2014. Foraging areas recorded in both August and September 2014, overlapped in woodland and field boundaries in the Menlo Castle and Menlough Village areas; suggesting that these areas were core foraging areas. See Figures 57 and 58 in **Appendix A.8.7**. The area of overlapping areas from August and September 2014 was 11.96km^2 (MCP) or 8.1km^2 (MLP). Field systems and quarries north-east and east of Menlo Castle and field systems north of Cooper's Cave also served as foraging areas. The majority of Lesser horseshoe bat foraging areas in August and September 2014 overlapped in the area of the River Corrib, field boundaries and woodland around Menlo Castle and Menlough Village, limestone pavement, woodland, scrub and lake around Coolough and Menlough Village, field boundaries and scrub around Castlegar and Ballindooley Lough, and an abandoned quarry in Angliham.

None of the foraging areas recorded in 2014 extended south of the existing N6, towards Galway City.

In May 2015, four bats were captured and tagged. Two of the bats had been captured, tagged and ringed in 2014. Rings were placed on the new bats.

Three day roosts were identified during the radio-tracking session in 2015. Three out of the four bats consistently used the maternity roost in Menlo Castle (PBR06). One bat utilised a previously-unknown roost in a boulder field located in an abandoned quarry just south of Coolagh Lakes (PBR218) over several days before

[40] MCP = Minimum convex polygon
[41] MLP = Multilateral polygon

returning back to Menlo Castle (PBR06). Another bat used a void within a natural limestone structure located within Menlough Woods to roost (PBR219). All of these daytime roosts were also used for short periods of resting at night.

The overall foraging area of Lesser horseshoe bats tracked in 2015 covered 16km^2 (MCP) or 10.22km^2 (MLP). The core foraging area of all bats extended over 1.25km^2. The majority of foraging areas overlapped in the area of Menlo Castle, Menlough Woods and Menlough Village in a similar pattern recorded in 2014. This was considered to be the core foraging area from where bats travelled both, north towards Lough Corrib and south following the River Corrib, in some cases all the way to the coast of Galway.

The overall foraging area in 2015 was smaller than recorded in the late summer/early autumn tracking periods in 2014. It is likely that the low night-time temperatures in 2015 resulted in shorter foraging periods and shorter travel distances.

Based on the results of the radio-tracking studies carried out in 2014 and 2015, it was concluded that Lesser horseshoe bats utilised existing woodlands, field boundaries and watercourses for foraging and navigating during this period. Areas of scrub over limestone pavement were often used as foraging areas for prolonged periods of time. Quarries in the Galway area appeared to be of importance to Lesser horseshoe bats with records of bats spending time both feeding and night roosting there. Areas used both during the late maternity period in summer as well as for foraging in preparation for hibernation in late summer are regarded to be crucial in supporting the local Lesser horseshoe bat population.

The radio-tracking studies confirmed a strong link between the maternity roost present at Menlo Castle (PBR06) and Cooper's Cave (PBR112). Although there was a direct connection between both sites via the River Corrib and Terryland River, the radio-tracked bats tended not to utilise this potential commuting route and instead travelled overland via Lackagh Quarry to the Terryland River Valley, via a small area of green space around Castlegar Village. Bats were regularly recorded commuting between the roosts and have been confirmed to be a part of the same Lesser horseshoe bat population.

Radio-tracking data also suggested that Cooper's Cave (PBR112) is an important roosting site for male Lesser horseshoe bats in summer and an important autumn mating site in the area, as well as a hibernation site, for this species.

In order to record and assess bat activity within the lands proposed for habitat enhancement, four SM2BAT+ ultrasound detectors were placed along hedgerows from 28 July - 11 August 2017. Detectors were also placed in hedgerows on the bóithrín at Menlo which is crossed by the proposed road development. Lesser horseshoe bats were recorded at both locations with 132 recordings made in the proposed habitat enhancement lands and 81 recording made along the bóithrín. An SM2BAT+ detector was also deployed from 2 – 15 May 2018 at one of the same locations within the lands proposed for habitat enhancement and two detectors were also deployed in the field to the south toward the River Corrib in order to measure usage of different areas over the same time period. On this second occasion, Lesser horseshoe bats were recorded at all three locations with 102 recordings made by the two detectors in the fields to the south and only 12 recordings in the proposed habitat enhancement lands.

These results demonstrated that the proposed habitat enhancement area was accessible for Lesser horseshoe bats and is a suitable area for increasing the amount of foraging habitat within it.

Analysis of the relative importance of Menlo Castle

Counts of Lesser horseshoe bats made at Menlo Castle were compared to other roost counts in County Galway and beyond to determine the level of importance of Menlo Castle. Based on counts from 2006 - 2016, the maternity roost at Menlo Castle makes up approximately 0.6% (min 0.1% - max 0.6%) of the summer population of Lesser horseshoe bats for the national population of this species and 6% (min 2% - max 6%) of the County Galway summer population. Therefore, while the roost at Menlough does not meet the threshold of representing 1% of the national population to make it of National Importance (National Roads Authority, 2009), it does exceed this threshold at the county level and therefore is regarded to be of County Importance.

Based on the distribution of maternity roosts in the range of this species in Ireland, the Menlo Castle maternity roost and the local population it supports meets the criteria of being of National Importance, whereby "a smaller population may qualify as nationally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle." (National Roads Authority, 2009).

There are only six known maternity roosts in and around Lough Corrib, with the majority of roosts concentrated on the northern shores near Cong. Only two roosts are located on the southern end: Ross Lake Gatehouse and Menlo Castle. These southern roosts may be an important stepping-stone for long-term movements and gene flow between bat populations in North Galway and Mayo and populations in South Galway and Clare. Recent counts from Ross Lake Gate House have shown that this roost has undergone significant deterioration resulting in decline in numbers from 150 bats in 1994 to five bats in 2011 (Rebecca Teesdale pers. comm., 2014 and p44 in Roche et al, (2015)). A decline in the Ross Lake roost could potentially increase the relative importance of the roost at Menlo Castle as a stepping stone roost as it would be the only significant maternity colony at the southern end of Lough Corrib. There is no evidence to suggest that Menlo Castle Lesser horseshoe bat population is connected to the Eborhall Lesser horseshoe bat population, which is the qualifying interest (QI) population for Lough Corrib cSAC. Any predicted impacts on Lesser horseshoe bats associated with the proposed road development will not affect the conservation objectives of the Lough Corrib cSACs QI Lesser horseshoe bat population, nor the QI Lesser horseshoe bat populations of any other European sites.

The numbers of bats using Cooper's Cave (PBR112) is hard to quantify due to the lack of access to roosting areas underground and the seasonal and gender specific variability in its use. It clearly is used by males and females some of which roost there in summer and also use it for mating. The cave system also supported a small population of hibernating Lesser horseshoe bats (usually averaging 4 bats) although the cave system could not be accessed in its entirety, so more bats could have been present further underground. The surveys have indicated that Menlo Castle and Cooper's Cave provide hibernation conditions for the local population although since both locations cannot be fully accessed to count individuals, the population size cannot be fully determined. Given the lack of other maternity roosts in the locality which could otherwise be a source of additional bats to occupy hibernacula, it is very unlikely that the winter roost population differs from the summer roost population in the Menlo Castle-Cooper's Cave complex.

8.3.7.2.2 Leisler's bat Nyctalus leisleri

The results of the bat surveys as they relate to Leisler's bat are shown on **Figure 8.19.1**.

Historical records

Leisler's bats have been recorded across the scheme study area as bat detector records and have also been recorded using bat boxes in Rusheen Bay, which are the only previous roost records for this species. Detector records include NUIG (A.P. McCarthy Planning Consultants (2007a), McCarthy, Keville & O'Sullivan (2014a) McCarthy, Keville & O'Sullivan (2014b)), Moycullen and Ballycuirke Lough (Galway County Council/Roscommon National Roads Design Office (2011). Since this bat can travel long distances from its roost each night, detector records do not necessarily suggest that bats are roosting nearby.

Identification of Roosts

No winter roost sites were recorded in any of the surveys for the proposed road development. Radio-tracking of three bats captured in 2014 and 2015 provided locations of four day roosts (PTR45, PB134, PBR139, PBR146).

In 2014, a single male Leisler's bat was captured and tagged in Menlough Woods. Radio-tracking indicated that the maximum distance that this individual was recorded travelling was 4.85km over a foraging area of 8.96km^2 that encompassed the southern area of Lough Corrib, the River Corrib and the Menlough area. Two roosts used by this individual were also located; a large modern house along the N84 Headford Road near Ballinfoyle and an Ash tree at the edge of Menlough Woods (PTR45).

Another two male Leisler's bats were captured, ringed and tagged in Bearna Woods in the second session in 2014. However, data was only collected for one of these bats as the second could not be located. The bat that could be tracked was found to roost during the day at two modern dwelling houses on the Cappagh Road (PBR139, PBR146). This bat had a recorded foraging area of 13.62km^2 (MCP) that encompassed the southern area of Lough Corrib, along the River Corrib corridor and the Menlough area.

Evidence of bat activity

Leisler's bats were recorded widely across the scheme study area during the walked and vehicle transect surveys. However, few calls were recorded within the city limits. The species was recorded at every static detector location.

The static detectors deployed in 2015 recorded Leisler's bats at 32 locations (out of a total of 42) along the route of the proposed road development. The highest levels of activity were recorded over the River Corrib (RS7) and Lackagh Quarry (RS13).

During the crossing point surveys, indications of potential crossings were recorded at 6 sites for Leisler's bat; CP5, CP6, CP8, CP10, CP14, CP15. It is reasonable to assume that the approach taken for detecting bat crossings of the proposed road development by this species is not as effective as it might be for other species. The Leisler's bat loud echolocation calls would be received by both microphones simultaneously and crossings would not be possible to prove. However, since this is a fast and high-flying bat it is regarded to be less impeded by severance of features at ground level (an "open airspace species" according to Elmeros et al, 2016).

8.3.7.2.3 Common pipistrelle bat Pipistrellus pipistrellus

The results of the bat surveys as they relate to the Common pipistrelle bat are shown on **Figure 8.21.1**.

Historical records

Common pipistrelle bats have been recorded across the scheme study area including the grounds of NUIG (A.P. McCarthy Planning Consultants (2007a), McCarthy, Keville & O'Sullivan (2014a) McCarthy, Keville & O'Sullivan (2014b)). None of these would appear to be records of roost sites and are generally records from bat detector surveys.

Identification of locations used in summer

Building inspections carried out in 2014 and 2015 identified four roosts used by Common pipistrelle bats. One was located in an outbuilding in the Ballindooley area (PBR07), a small roost of 3-4 bats was found in a large shed adjacent to the N83 Tuam Road in Cappanabornia (PBR228) and single bats were observed at the stable block in Galway Racecourse in Ballybrit (PBR205) and an abandoned bungalow to the north of Bearna Village (PBR220).

Six Common pipistrelle bats were captured during the radio-tracking session in 2014; two at NUIG, two at the NUIG Sporting Campus, and two at Menlough Woods. The male and female bats captured in NUIG were tagged, ringed and tracked to their day roosts. The female was found to roost in two modern buildings in a housing estate at Ballymoneen (PBR141, PBR147) on the north western edge of the city, while the male was found to roost in two modern agricultural barns in Cloonacauneen (PBR148, PBR149), to the north of the Roadstone Quarry.

No winter roosts for this species have been recorded.

Evidence of bat activity

Common pipistrelle bats were recorded widely across the scheme study area during the walked and vehicle transect surveys. However, very few calls were recorded within the city limits, apart from areas adjacent to the River Corrib. The species was recorded at every static detector location in 2014.

The static detectors deployed along the proposed road development recorded Common pipistrelle bats at 34 locations. The highest level of activity was recorded in Lackagh Quarry (RS13), a hedgerow in a field adjacent the N83 Tuam Road (RS26), a hedgerow adjacent to the existing N6 roundabout (RS29) and along a hedgerow bordering the Barr Aile Road, north of Bearna Village (RS40).

During the crossing point surveys, possible crossing records were recorded at 16 sites for Common pipistrelle bats. Seven sites recorded more than 10 possible crossings for this species; CP6, CP9, CP10, CP11, CP14, CP15, CP16. Relatively high number of possible crossings were recorded at CP9 (88 possible crossings) and CP10 (630 possible crossing records).

8.3.7.2.4 Soprano pipistrelle bat *Pipistrellus pygmaeus*

The results of the bat surveys as they relate to the Soprano pipistrelle bat are shown on **Figure 8.21.1**.

Historical records

This species has been previously recorded across the scheme study area and included records at Dangan, (A.P. McCarthy Planning Consultants, 2007a), Merlin Park (Browne and Fuller, 2009), Bearna Woods (Browne et al, 2009), Ballyquirke (Galway County Council/Roscommon National Roads Design Office, 2011) and NUIG (McCarthy, Keville and O'Sullivan, 2009a, 2014a, 2014b). A historical record was also provided by the NPWS of a roost from Menlough Village in 2014 (R. Teasdale, pers. comm, 2015) a single bat was known to roost in Menlo Castle in 2000 (RPS, 2006)

Identification of locations used in summer

Building inspections carried out in 2014, 2015 and 2016 identified 13 roosts of this species. These were located in Aubwee, Ballybrit, Ballindooley, Letteragh, Gortacleva, Roscam, Bearna Woods, Bearr Aile, Truskey West, Aughnacurra and Coolagh. Seven of these roost sites were at locations with unoccupied farm buildings and houses (PBR196, PBR205, PBR237, PBR241, PBR42, PBR44, PBR49), and roosts were found in occupied buildings in Bearna Woods (PBR222), Aughnacurra residential estate (PBR177, PBR255) and Coolagh (PBR179).

A single Soprano pipistrelle bat was observed emerging from an oak tree (PTR40) in a field located to the south of Menlo Castle in the summer of 2015.

Evidence for bat activity

Soprano pipistrelle bats were recorded widely across the scheme study area during the walked and vehicle transect surveys. However, very few calls were recorded within the more developed areas within Galway City apart from areas adjacent to the River Corrib. This species was recorded at all 24 static detector locations deployed in 2014.

The static detectors deployed in 2015 recorded soprano pipistrelle bats at 37 (out of a total of 42) locations along the route of the proposed road development. The highest levels of activity were recorded near the River Corrib (RS1 and RS2), in proximity to a confirmed roost in Aughnacurra Housing Estate (RS8) and a hedgerow adjacent to the existing Coolagh Roundabout (RS29).

During the crossing point surveys, bat activity suggesting possible crossings was recorded at all 21 survey locations for soprano pipistrelle bats. Thirteen sites along the route of the proposed road development recorded more than 10 possible crossing records for this species.

8.3.7.2.5 Nathusius' pipistrelle bat *Pipistrellus nathusii*

The results of the bat surveys as they relate to Nathusius' pipistrelle bat are shown on **Figure 8.20.1**.

Historical records

This is the only bat species that has not been previously recorded in the scheme study area. Only one record exists at a county level for an ad-hoc observation made in Oughterard in 2007, according to the Bat Conservation Ireland database.

No roosts were found for this species.

Evidence for bat activity

Nathusius' pipistrelle bats were recorded during the walked and vehicle transect surveys in 2014 but on a much rarer basis than the other two *Pipistrellus* species. They were recorded in an area of farmland east of Galway Technology Park, Bearna Woods, Coolagh Lakes and Letteragh.

The species was recorded at 20 (out of a total of 24) static detector locations in 2014, although they again were much less frequent than the other *Pipistrellus* species but suggested that the species was more widespread than was shown by the walked and vehicle transects. Sites with highest numbers of calls included S20, S16, S21 and S06, which were located around the River Corrib.

The static detectors deployed in 2015 along the route of the proposed road development recorded Nathusius' pipistrelle bats at one (out of a total of 42) location, in Lackagh Quarry (RS13), where two calls were recorded.

During the crossing point surveys, evidence for Nathusius' pipistrelle bats crossing the route of the proposed road development were recorded at CP14 and CP20 (2 out of a total of 21). Only single "passes" were recorded.

8.3.7.2.6 Unidentified Pipistrelle Species *Pipistrellus* sp.

The results of the bat surveys as they relate to Pipistrelle bats, not identified to species level, are shown on **Figure 8.21.1**.

Common pipistrelle bats have their peak echolocation call strength at 45kHz and Soprano pipistrelle bats at 55kHz. Pipistrelle bat species that echolocate between 48 and 52kHz cannot be accurately identified by their calls and are described as "unidentified" Pipistrelle bat species.

Identification of locations used in summer

No winter roosts for this species were recorded.

Two unidentified Pipistrelle bat roosts were recorded during building inspections in 2014 and 2015. A roost of unknown number was found in a farm house to the west of Bearna Village (PBR224) during an internal survey whilst an old unidentified Pipistrelle bat dropping was found in a bungalow within the grounds of Galway Racecourse in Ballybrit (PBR242).

An unidentified Pipistrelle bat was observed with an endoscope in a crevice in an ash tree (PTR54) in hazel scrub on limestone pavement located to the north of Coolagh Lakes in 2015.

Evidence for bat activity

Bat calls that could not be assigned to either Common or Soprano pipistrelle bats were recorded widely across the study area during the walked and vehicle transects undertaken in 2014. The static detectors deployed in 2015 recorded unidentified Pipistrelle bats at 32 locations along the route of the proposed road development. The highest activity was recorded near the River Corrib (RS1), Lackagh Quarry (RS13) and along a hedgerow near Castlegar Village (RS19).

The static detectors deployed in 2015 recorded unidentified Pipistrelle bats at 32 (out of a total of 42) locations along the route of the proposed road development. During the crossing point surveys, bat activity suggesting possible crossings were recorded at 14 (out of a total of 21) sites for unidentified Pipistrelle bat species. Two sites recorded more than 10 possible crossing records for this species group: CP9 and CP10.

8.3.7.2.7 Brown long-eared bat *Plecotus auritus*

The results of the bat surveys as they relate to the Brown long-eared bat are shown on **Figure 8.20.1**.

Historical records

Baseline data, presented in documentation supporting planning applications in the scheme study area, have recorded a Brown long-eared bat roost of more than 20 bats in Menlo Castle (RPS, 2006) although this was not recorded during the current series of surveys. This commonly-occurring and widespread species is known to occur in Merlin Woods (Browne and Fuller, 2009), NUIG Campus (McCarthy, Keville and O’Sullivan. (2014a)), Clydagh Bridge and Ballyquirke (north of the scheme study area) (Galway County Council/Roscommon National Roads Design Office. (2011). Bat Conservation Ireland records for this species show a small number of records in the scheme study area.

Identification of locations used in summer

27 roosts of this species were recorded during the building inspections in 2014-2017. Seven of the roosts could support maternity colonies; a period house on the Letteragh Road (PBR49), Merlin Castle (PBR51), an abandoned bungalow on the R338 to Oranmore (PBR89), a barn on the R399 east of Ballybrit (PBR100), the

attic of two houses in Aughnacurra Housing Estate (PBR178, PBR256) and a modern house in the Heath Housing Estate (PBR173).

Twelve additional roosts were also classified as night roosts, while the remaining eight were not classified. The night roosts were found in the following locations; an abandoned house adjacent to the Corinthians RFC (PBR21), an abandoned house in Rockmount (PBR15), an abandoned three outbuildings near Ballindooley Lough (PBR17, PBR25, PBR111), an outbuilding and archway in Menlough (PBR82, PBR156), an unfinished modern house in Gortacleva (PBR138), a shed in Barr Aile (PBR217), and a shed in Garraun (PBR194), cottage in Ballintemple (PBR105).

During the radio-tracking in August 2014, four brown long-eared bats were captured; two bats at Bearna Woods, one bat at Menlough Woods, and one bat at Cooper’s Cave. The female brown long-eared captured at Cooper’s Cave was fitted with a radio transmitter and tracked to its daytime roost; a bungalow in Castlegar (PBR145). An emergence count carried out on this building observed six bats leaving the roost. As this bat was an adult female it is likely that this building was being used as a maternity roost. This bat was also tracked during the September radio-tracking session and was found to repeatedly roost in the same bungalow. On one night the bat was recorded night roosting in a stone arch between Menlough Village and Menlo Castle (PBR156) during heavy rain. The maximum commuting distance recorded for this individual in a single night was approximately 4.07km. The foraging area of 2.18km^2 (MCP) mainly encompassed the valley where Cooper’s Cave was located but also around Ballindooley Lough.

Evidence for bat activity

Brown long-eared bats were only recorded at two locations during the walked and vehicle transects but these results are typical for this bat species which echolocates very quietly and is therefore difficult to pick up on a heterodyne bat detector on a moving transect. However, they were recorded at 18 (out of a total of 24) static detector locations in 2014, indicating that the species is quite widespread in the scheme study area, consistent with the findings of the summer roost surveys.

The static detectors deployed in 2015 recorded brown long-eared bats at only two (out of a total of 42) sites along the route of the proposed road development, adjacent to the River Corrib (RS1 and RS7).

8.3.7.2.8 *Myotis* bat species

The results of the bat surveys, as they relate to bats identified to the *Myotis* genus level, are shown on **Figure 8.20.1**.

The *Myotis* genus includes three bat species resident in Ireland: Daubenton’s bat *Myotis daubentonii*, Natterer’s bat *M. nattereri* and the Whiskered bat *M. mystacinus.* There can be difficulty in differentiating between the bats using their echolocations calls as there can be similarity between them. Therefore, they have been grouped together for the purposes for reporting these results.

Historical records

Previous bat studies have reported in excess of 20 Daubenton's bats recorded roosting in southern façade of Menlo Castle in 2000. There was no roost recorded in 2005 and 2006, but bats were recorded foraging. Less than 30 Natterer's bats were recorded roosting in outbuildings of Menlo Castle in 2000 but no roost was recorded in 2005 and 2006 ((RPS, 2006). Myotis bats were recorded on the NUIG Campus (McCarthy, Keville & O'Sullivan (2014). There was also an historical record of a roost of Natterer's bats at St James's Church, Bushypark. Natterer's bats were also recorded as part of the surveys carried out for the proposed R336 to N59 Road Scheme (RPS, 2013a). Daubenton's bats have been recorded on the River Corrib from the NUIG campus (McCarthy, Keville and O'Sullivan. (2014a, 2014b)) and also in most watercourses within the city and around its environs. This species is regularly sighted around the Galway Cathedral during bat walks by Galway Bat Group (C. Carlin, pers comm 2015).

Whiskered bats are rarely recorded across the area and only *ad-hoc* records from Bat Conservation Ireland exist.

Identification of locations used in summer

Four Natterer's bat roosts were recorded during the inspections of buildings in 2015 (PBR17, PBR20, PBR64, PBR82). These roosts were confirmed based on the presence of droppings, which were analysed using DNA sequencing to confirm the species identity.

An emergence survey of Menlo Castle (PBR06), carried out on the 8 July 2014, found Daubenton's bats to be still roosting in the castle. Numbers of bats were estimated to be less than 20 bats.

During the radio-tracking in August 2014, nine Daubenton's bats (one female and eight males) were captured in Menlough Woods and a single male Daubenton's bat was captured at Cooper's Cave. One of the male Daubenton's bats captured in Menlough Woods was tagged and tracked. It was found to roost in a stonewall structure on the eastern bank of the River Corrib (PBR133). An emergence count undertaken shortly after recorded 25 Daubenton's bats to be roosting in the wall, suggesting that this was likely to be a maternity roost for this species.

During the second radio-tracking session in August, ten Daubenton's bats were captured (one from Merlin Wood, three from NUIG, and six from Menlough Woods) and four were tagged (one female from Merlin Wood, two females and one male from NUIG). Roosting information was recorded for three of the Daubenton's bats tracked during the second August session. They were found to roost in three buildings (PBR142, PBR143, PBR144) and two bridges (PBR150, PBR152) in Galway City Centre. Foraging data was recorded in the September tracking session for two Daubenton's bats that were captured during the second August session. One bat travelled a maximum distance of 1.06km and had a foraging area of 0.26km^2 (MCP) encompassing Merlin Woods and the Coolagh lakes. The other had a maximum distance of 2.48km and had a foraging area of 0.55km^2 (MCP) encompassing the River Corrib from Menlo Castle into Galway City Centre.

Two male whiskered bats were captured and tagged during the second radio-tracking session in August 2014 (one from NUIG and one from Merlin Woods). However, the bat caught in Merlin Woods could not be relocated after tagging. The other Whiskered bat was found to roost in two modern dwelling houses (PBR140, PBR151) in a residential estate by the Sports Centre, near Bearna Woods. Foraging data for this individual was gathered during the September radio-tracking session. The maximum distance this bat travelled was 3.71km and had a foraging area of 2.02km^2, encompassing areas of scrub and rough grassland in the Bearna area.

A Natterer's bat was captured in Menlough Woods in August 2014 but was not prioritised for tracking at that time and hence not fitted with a radio-tag. Another male Natterer's bat was captured, ringed and tagged in Menlough Woods during the September radio-tracking session; however, no data was recorded from this bat, possibly due to the bat leaving the area, or transmitter failure.

Evidence of bat activity

During the walked and vehicle transect surveys and the static detector surveys in 2014 and 2015, the majority of *Myotis* calls were not identified by species due to the overlap in call characteristics between species when analysed. However, on a number of occasions, *Myotis* species were confirmed by visual observations coinciding with echolocation calls. Natterer's bats were recorded at Bearna Woods and Daubenton's bats were seen foraging on the River Corrib and the Terryland River. The majority of *Myotis* bat calls were recorded along the River Corrib and Terryland River during the walked and vehicle transects but were infrequently recorded across the rest of the scheme study area.

Myotis calls were recorded across all 24 static detector locations in 2014, although at a lower frequency than pipistrelle species. Location S07 recorded the highest amount of *Myotis* activity. This site was close to the River Corrib and the known Daubenton's maternity roost.

The static detectors deployed in 2015 along the route of the proposed road development recorded *Myotis* bats at 25 (out of a total of 42) locations. Activity levels for this species at static locations along the route of the proposed road development was low for this species group but the highest activity was recorded along the River Corrib (RS1), Lackagh Quarry (RS13), an area of woodland adjacent to the N84 Headford Road near Ballindooley and along a stream surrounded by fields and scrub in Ballard East.

During the crossing point surveys, possible crossing records were recorded at 7 (out of a total of 21) sites for *Myotis* bat species, with 1-3 possible crossings recorded at each of these sites.

8.3.7.2.9 Survey Limitations

A total of 230 structures and 62 trees were assessed as part of the collection of baseline data on the bat populations within the area of the proposed road development. This unprecedented level of surveying allowed a detailed picture of the species assemblage present in the study area and informed the constraints and route selection studies, the design of the proposed road development and the preparation of this EIAR.

All structures within the proposed development boundary which may be affected, either directly or indirectly, were surveyed to record potential usage by bats. In most cases it was possible to carry out internal and external checks for signs of bats in daytime as well as dusk and/or dawn surveys. Inevitably in a few cases, access to inside the structure was not possible. In such cases, surveys at night were undertaken to record any bats emerging from or returning to the structure.

Some surveys (e.g. radio-tracking surveys in 2015) may have been affected by cool night time temperatures and may have forced bats to reduce foraging time. Overall, the repeated surveys carried out since 2014 have allowed bats to be surveyed over multiple seasons which reduce the bias caused by suboptimal weather conditions.

8.3.7.3 Badger

Badger, and their breeding and resting places, are protected under the Wildlife Acts.

Evidence of Badger *Meles meles* activity was found across the study area from Na Foraí Maola to the N83 Tuam Road. The highest concentrations of badger activity were recorded in the Menlough area and the area between Lackagh Quarry and the N84 Headford Road. The survey results show a much greater distribution of Badgers across the study area than suggested by the findings of the desktop review. There was a single 2km grid squares (M32I) where the National Biodiversity Data Centre (NBDC) database had a record for Badger but the species was not recorded in that overlapping portion of the mammal survey study area and M32I. However, the survey did record Badger 50m to the north.

A total of 17 badger setts were identified both within and in the vicinity of the study area. The majority of setts were recorded as part of the 2015 multidisciplinary survey but some records for setts further from the proposed road development were recorded in 2014, during the course of other survey work. Sixteen were active at the time of the survey with the remaining sett (S1) showing no signs of recent use. The status, description and distance from the proposed development boundary of each of the setts is provided below in **Table 8.21**. The results of the mammal survey are shown in **Figures 8.3.1** to **8.3.14**.

Table 8.21: Results of the Badger survey – Badger setts

Ref. No.	Type of sett[42]	Status and description
S1	Disused sett	Inactive sett located beneath blackthorn tree. Single entrance. c.160m south-east of the proposed road development at Ch. 3+930
S2	Potential main sett	Active sett located in area of scrub along field boundary;

[42] Main sett = breeding sett, focus of most badger activity; Annexe sett = large sett, usually within 50m of the main sett; Subsidiary sett = smaller sett, not peripheral, within territory of badger social group; Outlier sett = small sett, usually on periphery of group territory; Minor sett = incidental sett, not on periphery of group territory.

Ref. No.	Type of sett[42]	Status and description
		numerous tunnels/pathways into the undergrowth c.90 m north-west of the N59 Link Road South at Ch. 1+800
S3	Main sett	Active sett located in woodland near field boundary wall. Single entrance sett with abundant fresh spoil, bedding and latrines. Adjacent to (<5m from) the proposed road development at Ch. 9+500
S4	Annex sett	Active sett located amongst holly bushes under limestone boulder. Single entrance with fresh spoil, bedding and latrine. c.85m south-east of the proposed road development at Ch. 9+500
S5	Subsidiary sett	Active sett located along field boundary. Single entrance with bedding and latrine. c.430m south-east of the proposed road development at Ch. 9+500
S6	Main sett/Annex sett	Active sett located in area of scrub. At least two entrances fresh spoil, bedding. >500m from the proposed road development
S7	Main sett/Annex sett	Active sett located under limestone. Two entrances fresh spoil, bedding. >500m from the proposed road development
S8	Main	Active sett located between limestone boulders. 10 plus entrances. Latrines and abundant activity signs. c.55m south of proposed road development (Bóthar Nua tie-in) at Ch. 10+200
S9	Potential main sett	Active sett located in hazel woodland at base of boulder pile. Single entrance. Large spoil heap, fresh spoil and bedding present. Within proposed development boundary at Ch. 11+810

Ref. No.	Type of sett[42]	Status and description
S10	Subsidiary sett	Active sett with two entrances, located under scrub along field boundary. Fresh spoil and bedding. c.45m north-east of the proposed road development at Ch. 11+810
S11	Subsidiary sett	Active sett located in dense scrub at field boundary. Single entrance. Within proposed development boundary at Ch. 12+025
S12	Main	Active sett located in scrub along field boundary. Six entrances. >500m from the proposed road development
S13	Subsidiary sett	Active sett located within improved grassland field. Single entrance. Recent digging. c.130m south of proposed development boundary at Ch. 13+425
S14	Subsidiary sett	Active sett located along field boundary. Two entrances. Recently digging. Within proposed development boundary at Ch. 13+775
S15	Subsidiary sett	Active, single entrance. Recent digging. c.100m north-west of AR 13/03
S16	Subsidiary sett	Active, single entrance. Recent digging and fresh spoil/bedding present. c.150m to the west of the proposed N59 drainage
S17	Subsidiary sett	Active, two entrances. Latrines, recent digging and fresh spoil/bedding. c.52m north of the proposed N59 drainage

Survey Limitations

Due to the presence of dense vegetation/scrub cover there were some locations within the study area, and within the proposed development boundary, which could not be fully accessed during the survey. These are shown on **Figures 8.3.1** to **8.3.14**. No evidence of Badger activity was recorded around the perimeter, or in the vicinity of, any of the inaccessible areas directly affected by the proposed road development.

The inaccessible areas have been considered in determining the impact significance and are reflected in the mitigation strategy. Sufficient data was gathered to reliably inform the impact assessment despite not being able to fully access these areas.

8.3.7.4 Other Mammal Species

Pine marten *Martes martes* were recorded along the Monument Road in Menlough and would be expected to be present in woodlands in the area. Pine marten have also been recorded in Bearna Woods and at Mincloon (NBDC on-line database records).

Evidence of Wood mouse *Apodemus sylvaticus* and Red squirrel *Sciurus vulgaris* was recorded east of the River Corrib, in woodlands east of Menlough Village, around Lackagh Quarry west of the proposed N84 Headford Road Junction, and south of the Roadstone Quarry at Two-mile-ditch. Red squirrel is known from the Menlough area, Merlin Park Woods, Ballygarraun/Two-mile-ditch, and woodlands in the Ardaun area (NBDC on-line database records).

An Irish stoat *Mustela erminea hibernica* was recorded on Bóthar Nua (roadkill). Irish hare *Lepus timidus hibernicus* was recorded in various habitat types (i.e. scrub, wet/improved grassland) in the western part of the study area; including lands within the proposed development boundary. Both species have been recorded in the study area previously (NBDC on-line database records and McAney, 2010).

Other terrestrial mammal species protected under the Wildlife Acts and likely to be present and widespread given the habitat types and existing land uses, and existing records from the NBDC's online database, include the Hedgehog *Erinaceus europaeus* and the Pygmy shrew *Sorex minutus*. Based upon the findings of the desktop review, Galway Bay supports a diverse range of marine mammal species, including: Harbour seal *Phoca vitulina*, Grey seal *Halichoerus grypus*, Common dolphin *Delphinus delphis* and Harbour porpoise *Phocoena phocoena*. All cetacean species are also protected under the Habitats Directive (Annex IV).

Evidence of Fox *Vulpes vulpes* and Rabbit *Orytolagus cuniculus* were also recorded across the study area. Evidence of Mink *Mustela vison* was recorded along the western bank of the River Corrib (*i.e.* north and south of Ch. 9+250) and a drainage ditch located near Ballindooly Lough (*i.e.* between Ch. 12+250 and Ch. 12+300). Bank vole *Myodes glareolus* and Wood mouse were recorded along a stream within the NUIG Sporting Campus. Although these species are not afforded legal protection under the Wildlife Acts, they form part of the local biodiversity resource and are noted here in that context.

8.3.8 Invertebrates

The following section presents the results of the baseline invertebrate surveys carried out to inform the impact assessment. Dedicated surveys were carried out for these species because they are legally protected (i.e. all are listed on Annex II of the Habitats Directive with the White-clawed crayfish and the Freshwater pearl mussel also protected under the Wildlife Acts) and, in the case of the Marsh fritillary butterfly and *Vertigo antivertigo*, that they are rare in Ireland[43] and at particular risk of habitat loss impacts associated with the proposed road development.

8.3.8.1 White-clawed crayfish

There were no White-clawed crayfish recorded at any of the survey sites within the scheme study area. No other evidence of the presence of the species within the scheme study area was observed (i.e. Otter spraints will commonly contain crayfish remains if they form part of their diet).

The survey was carried out in September 2014 during a period of low water levels, considered to aid in indicating those streams suitable of supporting White-clawed crayfish, and relatively high water temperatures, which would be expected to encourage crayfish activity.

All watercourses in the western part of the scheme study area were considered unsuitable to support the species, the water chemistry being too acidic and the lack of suitable habitat and/or quality; many of these streams were small or intermittent.

The Terryland River and the River Corrib appeared to be suitable for White-clawed crayfish but none were recorded. The Merlin Park Stream was considered unsuitable.

8.3.8.2 Freshwater pearl mussel

There were no populations, or individual records, of the Freshwater pearl mussel recorded within the scheme study area. The full results of the Freshwater pearl mussel surveys are provided in **Appendix A.8.11**.

The watercourses present were found to be poor habitat for the species, and although the Bearna Stream had good potential, no mussels were found. While the Lough Inch River itself had poor habitat and was affected by various pressures, this watercourse was upstream of, and in direct connectivity with, the Knock River - the confluence of the Lough Inch River and the Knock River is upstream of a known Freshwater pearl mussel population. The Knock/Lough Inch catchment is shown on **Figure 8.5.1**.

Although no freshwater pearl mussel were present with the ZoI of the proposed road development, impacts to salmonid fish species could indirectly affect the Freshwater pearl mussel population in Lough Corrib cSAC; the QI population is in the Owenriff River, c.23km to the north.

8.3.8.3 Other Annex II molluscan species

A total of 39 molluscan species were recorded during the molluscan survey, none of which were nationally or internationally rare or protected, with a range of between one and twelve species per surveyed site. The species assemblage recorded in some areas (e.g. Wetland habitats associated with the Coolagh Lakes and some

[43] The Marsh fritillary butterfly is listed as Vulnerable in *Ireland Red List No. 4 – Butterflies* (Regan et al., 2010) and *Vertigo antivertigo* as Vulnerable, in *Ireland Red List No. 2 – Non-Marine Molluscs* (Byrne et al., 2009)

Calcareous grassland habitat nearby) was considered to be of local interest. The full results of the molluscan surveys are presented in **Appendix A.8.12**. Species are listed according to the nomenclature of Anderson (2005).

There were no legally protected *Vertigo* species recorded during the survey. Three other Vertigo species (*Vertigo pygmaea*, *Vertigo antivertigo* and *Vertigo substriata*) were recorded, suggesting that the habitat conditions were not quite even in wetness and/or calcareous enough for the three Annex II *Vertigo* species. The remainder of the species recorded were typical of wet grassland, reed bed, riparian fringe, and fen habitats. Together the sites displayed a good range of species assemblage with good variety across the sites, reflecting the level of variation in wetness and vegetative succession of different areas. It should be noted that the Marsh whorl snail *Vertigo antivertigo* is listed as vulnerable in the Irish Red Data List of molluscs (Byrne *et al*., 2009). This species was recorded in wetland habitat on the east bank of the River Corrib between Menlo Castle and Menlo Graveyard and north of the outflow channel from the Coolagh Lakes, in the fringing wetland habitat along the western side of the Coolagh Lakes, at Ballindooley Lough and at the marsh in Castlegar.

The highest quality molluscan habitat was found towards the southern end of the Coolagh Lakes, concentrated in the high quality fen and transitional habitat areas (see **Figure 8.5.1** and the full survey report in **Appendix A.8.12**). Here the most concentrated searches for *Vertigo geyeri* were undertaken but no individuals of this species were found in the field or in samples removed for laboratory analysis.

The Marsh whorl snail population is valued as being of Local Importance (higher value).

8.3.8.4 Marsh fritillary

2013 Survey

The survey was conducted from 23 – 27 September 2013, covering 57 survey sites and approximately 491.8ha. Suitable Marsh fritillary habitat was recorded at 29 of those sites, unsuitable habitat at 17 sites, and the remaining 11 were not surveyed due to access restrictions. The area of suitable habitat accounted for 61.2ha, or 12.4% of the sites surveyed.

Two larval webs were recorded at a single site during the survey. However, two locations found to support relatively large concentrations of larval webs in 2014 were not surveyed in 2013. The full results of the 2013 Marsh fritillary survey are provided in **Appendix A.8.14**; the location of the larval webs are shown on **Figures 8.6.1** and **8.6.8**.

2014 Survey

A total of 196 polygons were surveyed in 2014, comprising a total area of 936ha. A total of 105 areas of suitable Marsh fritillary habitat were mapped, comprising a total area of 80.6ha. The quality of habitat ranged from marginal sparse through to good condition. Many areas were fairly rank and were likely to be limited in their longevity, with management often apparently abandoned or affected by access due to development in the vicinity.

A total of 111 webs were located within around 40 areas of suitable habitat. Eleven of the webs were located in four different areas identified as suitable habitat in the 2013 surveys but with no webs recorded in that year. The rest of the webs were recorded in areas that had not previously been surveyed. Webs located included both active webs and hibernation webs.

The full results are discussed in the 2014 Marsh fritillary survey report in **Appendix A.8.13**, and shown on **Figures 8.6.1** and **8.6.8**.

2015 Survey

In 2015, the survey switched from the larger scale of the scheme study area to a more focussed survey of suitable habitat patches within, and in the vicinity of, the proposed development boundary (see **Figures 8.6.1** and **8.6.8**). A total of 42.7ha were surveyed, comprising around 3ha within the proposed development boundary.

The majority of areas surveyed comprised suitable habitat, although levels of suitability varied (largely related to management issues specific to 2015). The exception to this was one area, comprising 1.15ha of suitable habitat in 2014 and holding Marsh fritillary webs, which was found to be largely lost due to infilling. It was noted that some areas that were of limited suitability in 2014 (largely due to heavy grazing), comprised suitable habitat in 2015. Conversely, some areas that were in good condition in 2014 were found to be overgrazed in 2015. In addition, one area that was considered to be suitable habitat in 2014 (though marginal) was considered to fall outside that classification due to ongoing agricultural improvement in 2015.

A total of 12 webs were located across five polygons within the survey areas (see **Figures 8.6.1** and **8.6.8**). This compares with 39 webs recorded with those same areas in 2014. No webs were recorded within the proposed development boundary. Webs located included both active webs and hibernation webs.

In 2014, webs were more widely spread throughout suitable habitat, while webs in 2015 were more limited in distribution. This may be attributable, in part at least, to the difference in weather in the two years. A relatively warm and settled summer in 2014 would allow for a good emergence season and distribution of adult females to new areas. Weather in 2015 provided sub-optimal conditions for the species both during the flight period and the early part of the larval stage. This has the potential to both limit distribution of the species at the adult stage and survival of the species at the early larval stage.

2016 Survey

A total of 42.4ha were surveyed on the 14, 15 and 26 September 2016, of which c.6.1ha was within the proposed development boundary.

A total of 56 webs were located within the survey areas in 2016 (see **Figures 8.6.1** and **8.6.8**), which compares with 12 webs recorded with the area in 2015 and 39 webs in 2014. In 2016, a total of 13 webs were recorded within the proposed development boundary, with a further 33 webs recorded within 50m of the proposed development boundary and 6 within 100m.

The section between Ch. 0+700 and Ch. 1+600 comprised a wide-ranging area of good quality habitat. Many areas in the eastern part were in better condition for the species than in the previous 2 years; possibly due to reduced grazing pressure. Despite this, webs were only recorded in the western part of the survey area.

The habitat area between Ch. 2+200 and Ch. 2+550 held an active and core population with the number of larval webs increasing from two in 2014, to seven in 2015 and to 35 in 2016. Although high quality habitat, the area between Ch. 2+900 to Ch. 3+050 only supported a single web in 2015 and again in 2016. The high-quality habitat area between Ch. 3+550 and Ch. 3+800 held 14 larval webs in 2016; compared with three in 2014 and a single web in 2015. The quality of the habitat in the area between Ch. 4+700 and Ch. 5+100 has deteriorated year on year over the survey period due to infilling and overgrazing and no larval webs were recorded here in 2016. No larval webs have been recorded in the suitable habitat areas at Ballagh (Ch. 7+700 to Ch. 8+000).

Overall, the Marsh fritillary butterfly population is valued as being of County Importance.

8.3.9 Birds

8.3.9.1 Breeding birds

All wild birds, and their nests and eggs, are protected under the Wildlife Acts. Some bird species are also listed on Annex I of the EU Birds Directive (see **Table 8.22** for those Annex I bird species recorded during the breeding bird surveys).

The results of the various breeding bird surveys carried out to inform this assessment are summarised below.

Breeding Bird Survey

The general breeding bird surveys recorded a total of 62 species across the study area, including; 3 species listed as SCIs for nearby SPAs, 2 Birds Directive Annex I species, 6 Red list[44], 23 Amber list and 33 Green list bird species.

Table 8.22 below provides a summary of the findings of the breeding bird surveys[45] with respect to those species which are of conservation concern and are considered to be Key Ecological Receptors (KERs):

- Special Conservation Interests (SCIs), for a breeding population, of nearby SPAs
- Species listed under Annex I of the Birds Directive (2009/147/EC)
- Red and Amber BoCCI species listed for their breeding populations
- The results of the breeding bird surveys are shown on **Figures 8.7.1** to **8.7.14** with the full list of bird species recorded provided in **Appendix A.8.22**. The full

[44] Birds of Conservation Concern in Ireland (BoCCI) after Colhoun & Cummins, 2013

[45] Surveys were also carried out to establish the local Barn owl breeding population (a BoCCI Red List species), which confirmed a nest site at Menlo Castle, and this species is also included in **Table 8.22**.

results of the desktop review are presented in **Appendix A.8.18**. Of note in that regard are the results of the bird surveys carried out in 2005/2006 as part of the N6 Galway City Outer Bypass project (RPS, 2006) which demonstrates the importance of the River Corrib corridor for bird species

Table 8.22: Breeding Birds of Conservation Concern Recorded during the Breeding Bird Survey[46]

Common name / *Latin name*/BoCCI Code	**Distribution in the study area**	**Conservation Importance**		
		BoCCI (breeding)	**Annex I**	**SCI[1]**
Barn owl *Tyto alba* (BO)	One nest site known at Menlo Castle	Red	-	-
Black-headed gull *Larus ridibundus* (BH)	Widespread throughout	Red	-	Lough Corrib SPA
Curlew *Numenius arquata* (CU)	Observed once at Ballindooley Lough	Red	-	-
Grey wagtail *Motacilla cinerea* (GL)	Observed once west of the Galway Racecourse	Red	-	-
Herring gull *Larus argentatus* (HG)	Widespread throughout, more frequent west of the River Corrib	Red	-	-
Meadow pipit *Anthus pratensis* (MP)	Widespread west of the River Corrib, and between Ballybrit and the existing N6	Red	-	-
Whinchat *Saxicola rubetra* (WC)	Ballagh area (single record)	Red	-	-
Cormorant *Phalacrocorax carbo* (CA)	Widespread west of the River Corrib	Amber	-	Inner Galway Bay SPA & Connemara Bog SPA
Common tern *Sterna hirundo* (CN)	Observed once at the proposed River Corrib Bridge	Amber	√	Inner Galway Bay SPA & Lough Corrib SPA
Coot *Fulica atra* (CO)	Observed between the River Corrib and Bóthar Nua, and once near Ballybrit	Amber	-	-
Great black-backed gull *Larus marinus* (GB)	Observed west of Bearna, at the River Corrib, and once at Ballindooley Lough	Amber	-	-

[46] Note that some of the species listed are also KERs for their wintering populations—see **Table 8.23**

Common name / *Latin name*/BoCCI Code	**Distribution in the study area**	**Conservation Importance**		
		BoCCI (breeding)	**Annex I**	**SCI[1]**
Goldcrest *Regulus regulus* (GC)	Widespread west of the River Corrib	Amber	-	-
Greenfinch *Carduelis chloris* (GR)	Widespread west of the River Corrib and east of the River Corrib, only recorded at Ballybrit	Amber	-	-
House martin *Delichon urbicum* (HM)	Observed near the Letteragh Road and between Ballindooley Lough and Ballybrit	Amber	-	-
House sparrow *Passer domesticus* (HS)	Observed near the Letteragh Road and at Ballybrit	Amber	-	-
Kestrel *Falco tinnunculus* (K.)	Observed near Bearna Woods, Letteragh Road, Lackagh Quarry and the existing N6	Amber	-	-
Lesser black-backed gull *Larus fuscus* (LB)	Observed once near Ballymoneen	Amber	-	-
Little grebe *Tachybaptus ruficollis* (LG)	Observed at the proposed River Corrib Bridge and Ballindooley Lough	Amber	-	-
Linnet *Carduelis cannabina* (LI)	Widespread throughout	Amber	-	-
Mistle thrush *Turdus viscivorus* (M.)	Observed at Ballard West, Knocknafroska, Menlough and Lackagh Quarry	Amber	-	-
Peregrine *Falco peregrinus* (PE)	Observed near Lackagh Quarry and the N83 Tuam Road	Green	√	-
Robin *Erithacus rubecula* (R.)	Widespread throughout	Amber	-	-
Skylark *Alauda arvensis* (S.)	Observed at Troscaigh Thiar, Cappagh and Ballybrit	Amber	-	-
Stonechat *Saxicola torquata* (SC)	Observed west of Bearna, near Cappagh, Knocknafroska and between Ballybrit and the existing N6	Amber	-	-

Common name / *Latin name*/BoCCI Code	Distribution in the study area	Conservation Importance		
		BoCCI (breeding)	Annex I	SCI[1]
Stock dove *Columba oenas* (SD)	Observed once near Clybaun Road	Amber	-	-
Starling *Sturnus vulgaris* (SG)	Widespread throughout	Amber	-	-
Sparrowhawk *Accipiter nisus* (SH)	Observed once at Galway Racecourse	Amber	-	-
Swift *Apus apus* (SI)	Observed twice near the NUIG Sports Campus	Amber	-	-
Swallow *Hirundo rustica* (SL)	Widespread west of the River Corrib, and observed near Ballybrit	Amber	-	-
Sand martin *Riparia riparia* (SM)	Observed around Lackagh Quarry and Ballindooley Lough	Amber	-	-
Wheatear *Oenanthe oenanthe* (W.)	Rahoon area (single record)	Amber	-	-

[1] Listed as SCIs for their breeding populations

Of note, was that Ringed plover were recorded twice during the breeding bird surveys, once in late May 2015 and once in late June 2015, exhibiting breeding behaviour near the western edge of Galway Racecourse.

Barn Owl Survey

A total of 76 sites were surveyed in 2014 for the presence of Barn owl within the study area for the proposed road development. A total of 47 (63%) sites were considered to be entirely unsuitable for Barn owl (Category 0). Of the remaining 29 (27%) sites which could potentially be used by Barn owl, 11 (14%) offered potential for roosting but not for nesting (Category 1). Five (6%) were assessed as having likely roosting and/or nesting opportunities (Category 2) and the remaining 13 (15%) offered excellent roosting and nesting opportunities (Category 3). The locations of the surveyed sites, and their suitability for Barn owl, are shown on **Figures 3.3** and **3.4** of the Barn owl survey report in **Appendix A.8.15**.

The presence of Barn owl was confirmed at five of these sites which are within the scheme study area. These included two castles (nest sites at Menlo Castle and Ardfry House), a ruined mansion (roost site at Rinville House), a derelict two-story farmhouse and a quarry (both roost sites). The distribution of these sites is shown on **Figure 8.8.1**. Two sites, Ardfry Castle and Menlo Castle, were confirmed as nest sites. A ruined mansion (Rinville House) was classed as regular roosts which are likely to be associated with both nesting pairs, and an independent occasional roosting site in a derelict farm house was also recorded. Monitoring revealed that both nesting sites failed to breed in 2014.

All sites which were classed as suitable for Barn owl during the 2014 survey (Category 2 and Category 3; 20 sites in total), were re-visited between June and August in both 2015 and 2016. Two sites (a farmhouse and cottage) which were previously classified as suitable (both Category 3) in 2014 had been demolished and were no longer available to Barn owl. All remaining 18 sites were deemed still suitable for Barn owl. Evidence of Barn owl occupation was recorded at two sites in 2015, namely Menlo Castle and Rinville House, both of which had been active in 2014. There were no signs to indicate recent use of Ardfry Castle, a farmhouse at Carnmore, or at Angliham Quarry where evidence of Barn owl had been recorded in 2014. In addition, a farmhouse with adjacent outbuildings at Ballard, where a Barn owl had been reported by a member of the public in the winter of 2015, showed no evidence of recent use in July 2015. Evidence of Barn Owl occupation was confirmed at a single site in 2016 (Rinville House).

Figure 4.7 and Table 4.2 in **Appendix A.8.15**, shows the distribution and suitability of all sites surveyed in 2015. As with 2014, no breeding sites were confirmed in either 2015 or 2016.

Barn Owl activity was not recorded at Menlo Castle in 2018 and the site was deemed to be unoccupied during that nesting season. There was no evidence of Barn Owl observed during day time inspections in and around the castle and no activity recorded by nocturnal watches.

<u>Other raptors recorded during the 2014 and 2015 Barn owl surveys</u>

Other raptor species which were encountered during survey work in 2014 and 2015 were also recorded. A total of 21 raptor and owl sites (not including Barn owl) were confirmed in 2014 and 2015, which included nine Kestrel sites (four nests and five roosts), six Peregrine sites (four nests and two roosts), three Sparrowhawk sites (two nest sites and one displaying pair) and three Long-eared owl nests, see Figure 4.10 in **Appendix A.8.15**.

Peregrine falcon Survey

Peregrine falcon occupancy was recorded in three quarries in the survey area in May and June 2016, all of which held breeding pairs (see **Appendix A.8.16**). One breeding pair was successful (Roadstone Quarry at Twomileditch), with pairs in two quarries (Angliham and Lackagh Quarries) failing to raise young. All three quarry sites which held breeding pairs in 2016 were known sites where Peregrine have previously nested and are regarded as traditional nesting sites. The specific nesting location was recorded for the single successful pair (Roadstone Quarry at Twomileditch) in 2016, for the other two quarries that supported nest sites (Angliham and Lackagh) it was not possible to record a nest location in 2016, however the location of the eyries in previous years is documented. In 2017, Lackagh Quarry was monitored to determine breeding status and the nest site location, which confirmed a breeding pair and which identified the location of the traditional nest ledge. In 2018, a breeding pair of Peregrine falcon was again confirmed in Lacklagh Quarry and was successful in fledging young. The nest site was also confirmed in 2018 although it was at a different location to that recorded in previous years.

Red grouse

No sightings, or evidence, of Red grouse was recorded during the survey; or during the general breeding bird survey. During the course of other survey work in September 2014 (and over the course of the winter bird survey work from October 2014 to March 2015), evidence of Red grouse (droppings) was recorded adjacent to the scheme study area at Na Foraí Maola/Lough Inch (Arup, 2016).

8.3.9.2 Wintering birds

The winter bird surveys recorded a wide range of bird species at sites across the study area.

Table 8.23 below provides a summary of the findings of the winter bird surveys with respect to those species which are of highest conservation concern, and were recorded within winter bird survey sites:

- Special Conservation Interests (SCIs), for a wintering population, of nearby SPAs
- Species listed under Annex I of the Birds Directive (2008/144/EC)
- Red and Amber BoCCI species listed for their wintering populations

The full results of the winter bird surveys (for all surveyed sites within the wider scheme study area) are provided in **Appendix A.8.23**. Other record for wintering bird species from Galway City and environs are presented in the full results of the desktop review in **Appendix A.8.18**. Of note in that regard are the results of the bird surveys carried out in 2005/2006 as part of the N6 Galway City Outer Bypass project (RPS, 2006) which demonstrates the importance of the River Corrib corridor for bird species.

Table 8.23: Wintering Birds of Conservation Concern Recorded during the Winter Bird Survey

Common name / *Latin name*	**Conservation Importance**		
	BoCCI (wintering)	**Annex I**	**SCI**
Bar-tailed godwit *Limosa lapponica*	Amber	✓	Inner Galway Bay SPA
Black-headed gull *Larus ridibundus*	-	-	Lough Corrib SPA Inner Galway Bay SPA
Bittern *Botaurus stellaris*	-	✓	-
Common gull *Larus canus*	-	-	Lough Corrib SPA Inner Galway Bay SPA
Cormorant *Phalacrocorax carbo*	Amber	-	Inner Galway Bay SPA

Common name / *Latin name*	**Conservation Importance**		
	BoCCI (wintering)	**Annex I**	**SCI**
Coot *Fulica atra*	Amber	-	Lough Corrib SPA
Curlew *Numenius arquata*	Red	-	Inner Galway Bay SPA
Golden plover *Pluvialis apricaria*	Red	✓	Lough Corrib SPA Inner Galway Bay SPA
Great crested grebe *Podiceps cristatus*	Amber	-	-
Great northern diver *Gavia immer*	Amber	-	Inner Galway Bay SPA
Grey heron *Ardea cinerea*	-	-	Inner Galway Bay SPA
Hen harrier *Circus cyaneus*	Amber	✓	Lough Corrib SPA
Lapwing *Vanellus vanellus*	Red	-	Inner Galway Bay SPA
Light-bellied brent goose *Branta bernicla hrota*	Amber	-	Inner Galway Bay SPA
Little grebe *Tachybaptus ruficollis*	Amber	-	-
Merlin *Falco columbarius*	-	✓	-
Mute swan *Cygnus olor*	Amber	-	-
Oystercatcher *Haematopus ostralegus*	Amber	-	-
Peregrine falcon *Falco peregrinus*	-	✓	-
Redshank *Tringa totanus*	Red	-	Inner Galway Bay SPA
Shoveler *Anas clypeata*	Red	-	Lough Corrib SPA Inner Galway Bay SPA
Snipe *Gallinago gallinago*	Amber	-	-
Teal *Anas crecca*	Amber	-	Inner Galway Bay SPA
Tufted duck *Aythya fuligula*	Red	-	Lough Corrib SPA
Turnstone *Arenaria interpres*	Green	-	Inner Galway Bay SPA
Wigeon *Anas penelope*	Red	-	Inner Galway Bay SPA

Seven bird species which are listed as SCIs for Lough Corrib SPA were recorded during the survey: Black-headed gull, Common gull, Coot, Golden plover, Hen harrier, Shoveler and Tufted duck. Given the potential link for these birds to the SPA populations, they are valued as being of International Importance.

Fifteen bird species which are listed as SCIs for Inner Galway Bay SPA were recorded during the survey: Bar-tailed godwit, Light-bellied brent goose, Black-headed gull, Cormorant, Common gull, Curlew, Golden plover, Grey heron, Lapwing, Great-northern diver, Redshank, Shoveler, Teal, Turnstone and Wigeon. Given the potential link for these birds to the SPA populations, they are valued as being of International Importance.

Six species listed on Annex I of the Birds Directive (2008/144/EC) were also recorded during these surveys (some of which are also SCIs of the SPAs discussed and valued above): Bar-tailed godwit, Bittern, Golden plover, Hen harrier, Merlin and Peregrine falcon. The non-SCI Annex I bird species are valued as follows: Bittern, as a scarce visiting species not listed as being of conservation concern nationally, is valued as being of County Importance; Merlin, as a species of medium conservation concern which is likely to have a limited population at a county level, is valued as being of County Importance; Peregrine falcon, as a species of low conservation concern but which is likely to have a limited population at a county level, is valued as being of County Importance.

Of the bird species recorded during the winter bird surveys, seven are on the BoCCI Red List for their wintering populations: Curlew, Golden plover, Lapwing, Redshank, Shoveler, Tufted duck and Wigeon. All are SCI species for the nearby SPAs and are valued accordingly.

Of the bird species recorded during the winter bird surveys, 12 are on the BoCCI Amber List for their wintering populations: Bar-tailed godwit, Cormorant, Coot, Great crested grebe, Great northern diver, Hen harrier, Light-bellied brent goose, Little grebe, Mute swan, Oystercatcher, Snipe and Teal. Those species listed as SCIs for the nearby SPAs are valued as above. Great crested grebe and Little grebe are likely to have a limited population at a county level and are valued as being of County Importance. Mute swan, Oystercatcher and Snipe are relatively common wintering species at a county level but are likely to have a more limited population at a local level and are valued as being of Local Importance (higher value).

Species Accounts

Brief species accounts from the winter bird surveys are provided for these species below; the winter bird survey site reference numbers are given below in parenthesis. For the locations of the winter bird survey sites, refer to **Figure 8.9.1**.

<u>Bar-tailed godwit</u>

Nine Bar-tailed godwit were recorded at one winter bird survey site, Ballindooley Lough (WB02), on a single occasion in February 2015.

<u>Black-headed gull</u>

Black-headed gull were the most frequently recorded species and were distributed widely across the area, but mainly east of the River Corrib (recorded from 10 out of 17 winter bird sites within the ZoI of the proposed road development), and in numbers ranging from single individuals to a flock of 119 birds. Those sites within the ZoI which recorded larger flocks of over 40 individuals were the River Corrib corridor (WB12) and the NUIG Sporting Campus (WB45).

Bittern

A single Bittern was recorded at the Coolagh Lakes (WB04) in February 2015.

Common gull

Common gull were recorded widely across the study area (recorded from eight out of 17 winter bird sites within the ZoI of the proposed road development) and in numbers ranging in size from single individuals to a flock of 78 birds. The species was most frequently recorded on the River Corrib (WB12) and at the NUIG Sporting Campus (WB45) – on six and three occasions respectively. Common gull were recorded more infrequently at the other surveyed sites, and in low numbers; they were only recorded on one of the seven survey visits at five of the eight sites within the ZoI. The largest flocks were recorded along the River Corrib corridor (WB12) where flocks of 48 and 78 were recorded in the area immediately upstream of the Salmon Weir in September and November 2014, respectively.

Cormorant

Cormorant were recorded at five winter bird survey sites within the ZoI of the proposed road development: Ballindooley Lough (WB02), Coolagh Lakes (WB04), An Chloch Scoilte (WB07), west of Lough Inch (WB08) and the River Corrib (WB12). However, in all instances the numbers recorded were low; generally, one or two individuals with the exception of a record for four in February 2015 along the River Corrib (WB12).

Coot

Coot were recorded at three of the winter bird survey sites within the ZoI of the proposed road development: Ballindooley Lough (WB02), the Coolagh Lakes (WB04), and along the River Corrib corridor (WB12). Although Coot were regularly recorded at all of these sites, the numbers were relatively low with a maximum of 11 recorded at Ballindooley Lough in February/March 2015.

Curlew

Curlew were distributed widely across the scheme study area, and were recorded at eight of the 17 winter bird survey sites within the ZoI of the proposed road development. At the majority of survey sites and dates on which they were recorded, fewer than 10 birds were present. The largest flocks were recorded along the River Corrib corridor (WB12) south of Glenlo Abbey Hotel where a flock of 16 was recorded in October 2014 and at Galway Racecourse (WB23)—in the playing pitch to the west of the racecourse (grid reference (ITM) 533091 727407) — where a flock of 37 were recorded January 2015. The species was only regularly recorded at Ballindooley Lough (WB02), where it was present on six of the seven survey visits, with eight or fewer birds present on each occasion.

Golden plover

Golden plover were recorded at one winter bird survey site within the ZoI of the proposed road development, WB08 to the west of Lough Inch, during four out of the seven survey visits. The species were recorded in relatively small numbers (maximum of nine birds) on all but one occasion, when a flock of 73 were recorded in November 2014.

Great crested grebe

Great crested grebe (two birds) were recorded once on the River Corrib corridor (WB12) near Glenlo Abbey Hotel in October 2014.

Great northern diver

A single Great northern diver was recorded in Galway Bay at Ballyloughaun (WB30).

Grey heron

Grey heron were recorded at six of the 17 winter bird survey sites within the ZoI of the proposed road development: Ballindooley Lough (WB02), Cappagh (WB03), Coolagh Lakes (WB04), An Chloch Scoilte (WB07), west of Lough Inch WB08, and the River Corrib corridor WB12. The species was recorded in relatively small numbers, a maximum of three birds were recorded at WB08 in March 2015, with most records being of single birds.

Hen harrier

A single Hen harrier was recorded in the area east of Lough Inch (WB06) in January 2015.

Lapwing

Lapwing were recorded at two winter bird survey sites within the ZoI of the proposed road development: Ballindooley Lough (WB02) where a flock of 16 and a single individual were recorded on January and March 2015 respectively; and, west of Lough Inch (WB08), where 17 were recorded in October 2014.

Light-bellied brent goose

Light bellied brent geese were recorded at Galway Golf Course (WB19), Nimmo’s Pier/Claddagh area (WB38) and along the coastline of Galway Bay between Roscam Point and Oranmore (WB71). The largest numbers were recorded at WB38 in January and March 2015 (127 and 83 respectively).

Little grebe

Little grebe were recorded at four winter bird survey sites: Ballindooley Lough (WB02), Coolagh Lakes (WB04), west of Lough Inch (WB08) and the River Corrib corridor (WB12). The numbers recorded were generally low (< five birds). The species were recorded on all seven survey visits at Coolagh Lakes (WB04) and the River Corrib corridor (WB12). The species was recorded on five out of seven of the survey visits (November 2014 through to March 2015) at Ballindooley Lough

(WB02) and only on one occasion in December 2014 at the survey site to the west of Lough Inch (WB08).

Merlin

A single Merlin was recorded in the area west of Lough Inch (WB08) in December 2014.

Mute swan

Mute swans were recorded at five winter bird survey sites: Ballindooley Lough (WB02), Coolagh Lakes (WB04), west of Lough Inch (WB08), the River Corrib corridor (WB12) and the Terryland River Valley (WB14). The numbers recorded were generally low (< eight birds). The species were recorded on all seven survey visits on the River Corrib corridor (WB12), with 14 birds recorded near Glenlo Abbey Hotel in February 2015. The species was recorded on six out of seven of the survey visits to the survey site west of Lough Inch (WB08) (September 2014 and November 2014 through to March 2015) and at the Coolagh Lakes (WB04) (October 2014 through to March 2015). The species was recorded on five out of seven survey visits to Ballindooley Lough (WB02) (October 2014 through to January 2015 and March 2015), and on one occasion on the Terryland River (WB14) in February 2015.

Oystercatcher

Oystercatcher were distributed widely across the scheme study area and recorded from five out of 17 winter bird sites within the ZoI of the proposed road development. Numbers ranged from single individuals to a flock of 34 birds. The sites that recorded larger flocks of over 20 individuals were the NUIG Sporting Campus (WB45) where 34 birds were recorded in December 2014.

Peregrine

Peregrine were recorded at one winter bird survey site within the ZoI of the proposed road development, at the Roadstone Quarry (WN17). At the Roadstone Quarry a single bird was recorded on three occasions in December 2014, February 2015 and March 2015. Peregrine were also recorded at Angliham Quarry, c.1km north of the proposed road development.

Redshank

Redshank were recorded at two winter bird survey sites within the ZoI of the proposed road development; west of Lough Inch (WB08) and the River Corrib corridor (WB12). Only two birds were recorded at WB08 in March 2015 and only single birds were recorded at WB12, near Waterside, in November and December 2014.

Shoveler

Shoveler were recorded on, or flying into, only one of the winter bird survey sites in 2014/15: Ballindooley Lough (WB02). They were recorded on five out of the seven survey visits, in numbers ranging from 10 to 144 birds.

Snipe

Snipe were distributed widely across the study area (recorded from eight out of 17 winter bird sites within the ZoI of the proposed road development) and in numbers ranging from single individuals to a flock of 37 birds. The numbers recorded across the sites were generally low (<10). Ballindooley Lough (WB02) had the largest flock of 37 in March 2015, with a flock of 28 in December 2014 and in September and November 2014 one and two birds respectively. A flock of 15 birds was recorded in November 2014 at the Terryland River Valley (WB14), and a flock of 14 recorded at the survey site to the west of Lough Inch (WB08) in January 2015.

Teal

Teal were recorded at five winter bird survey sites within the ZoI of the proposed road development: Ballindooley Lough (WB02), Coolagh Lakes (WB04), west of Lough Inch (WB08), Ballagh (WB10) and the Terryland River Valley (WB14). The numbers recorded at WB04, WB08 and WB10 were generally low (<6 birds) and Teal were not present regularly throughout the winter period (recorded on two, four and one occasion, respectively). Teal were recorded on, or flying into, Ballindooley Lough (WB02) and the Terryland River (WB14) during all survey visits. At Ballindooley Lough numbers ranged from three in September 2014, to 146 in January 2015, and at the Terryland River numbers ranged from nine in October 2014 to 29 in January 2015.

Tufted duck

Tufted duck were recorded at only one site, Ballindooley Lough (WB02), where the species was recorded on four occasions over the winter (November 2014, January 2015, February 2015 and March 2015). The maximum number recorded was a count of 26 in January 2015.

Turnstone

Five Turnstone were recorded in Galway Bay at Ballyloughaun (WB30) in October 2014.

Wigeon

Wigeon were recorded at one winter bird sites Ballindooley Lough (WB02) on one occasion in February 2015, when 28 birds were present.

8.3.10 Amphibians

Two amphibian species were known to be present within the study area; the Common frog *Rana temporaria* and the Smooth newt *Triturus vulgaris*[47]. Both are legally protected under the Wildlife Acts (including their breeding and resting places). Common frog have been recorded throughout the study area, most often in the upland habitats west of the River Corrib and along the River Corrib corridor. Smooth newt have been recorded in the vicinity of Bearna Woods, Salthill,

[47] Records from the National Biodiversity Centre's online database. For full details of the desk review, refer to **Appendix A.8.18**.

Terryland Park and at Renmore. Local landowners have also reported the presence of Smooth newt on lands near Coolagh Lakes.

During the surveys carried out in 2014, Common frog (adults, juveniles and tadpoles) were recorded at 21 of the 52 surface water/drainage features surveyed across the study area. Smooth newts were recorded at nine of the 52 surface water/drainage features surveyed across the scheme study area; most which were located west of the River Corrib. A summary of the Smooth newt survey results are provided below in **Table 8.24**.

Two ad-hoc observations of Smooth newt and four ad-hoc observations of Common frog were recorded within the study area during the multidisciplinary surveys.

The results of the amphibian survey are shown on **Figures 8.10.1** to **8.10.8**.

Table 8.24: Summary of Smooth newt records from the amphibian surveys

Location	Feature	Note
East of the proposed road development within area of scrub and rough grassland, c.35 m east of Ch. 0+500	Well	3 females and 3 males
South-east of the proposed road development within area of scrub, c.10 m south-east of Ch. 5+175	Pond	1 female
West of the proposed road development/Ballymoneen Road at Ch. 0+100	Drainage ditch	4 unidentified
North of the proposed road development within area of scrub, between Ch. 5+700 to Ch. 5+800	Drainage ditch	1 unidentified and 2 females
South of the proposed road development within area of scrub, c.50m south of Ch. 5+800	Drainage ditch	4 gravid females and 1 male
Within the proposed road development, south-east of proposed Letteragh Road Junction at Ch. 1+600	Pond	2 gravid females
Area of scrub within the proposed road development, east of proposed N59 Letteragh Junction at Ch. 7+850	Pond	1 juvenile male
Gravel wash-out ponds in Lackagh Quarry	Pond	1 unidentified
Cattle trough at Lackagh Quarry c.40m north of the proposed road development at Ch. 11+775	Cattle trough	1 female
Within Development boundary in marsh scrub area between Ch. 13+000 and Ch. 13+050	Pond	2 males, 1 female and 1 unidentified gravid female.
Galway Racecourse, >280m from the proposed road development	Drainage Ditches	10 males, 5 females, 5 unidentified (>20 newts). Gravid females present.

The Common frog and Smooth newt populations are valued as being of Local Importance (higher value).

8.3.11 Reptiles

There were records for the Common Lizard *Zootoca (Lacerta) vivipara* from Menlough, Merlin Park Woods, and various locations around Galway City: the River Corrib corridor, Salthill and Cappagh[48]. The Common lizard is legally protected under the Wildlife Acts (including their breeding and resting places).

The Common lizard survey was conducted between the 24 September and 4 October 2015. Common lizard were recorded at five of the 10 survey sites (A, B, C, E, and F); all of which were west of the River Corrib (**Figures 8.10.1** to **8.10.8**). All of these sites were within the footprint of the proposed road development, or adjacent to the proposed development boundary in habitat mosaics of heath, scrub and wet or acid grassland. The lizard survey results are summarised below in **Table 8.25**.

Table 8.25: Summary of Common lizard survey results

Survey Site	Result
A	27 / 28 September 2015 – 1 adult 28 / 29 September 2015 – 1 adult
B	24 / 25 September 2015 – 1 juvenile 27 / 28 September 2015 – 1 juvenile
C	27 / 28 September 2015 – 1 juvenile
E	25 / 26 September 2015 – 1 adult 26 / 27 September 2015 – 1 adult 28 / 29 September 2015 – 1 adult
F	24 / 25 September 2015 – 1 juvenile 27 / 28 September 2015 – 1 juvenile

One ad-hoc observation of the species was recorded at Knocknafroska during the multidisciplinary survey in May 2015, near the N59 Link Road North.

The results of the reptile survey are shown on **Figures 8.10.1** to **8.10.8**.

The Common lizard population is valued as being of Local Importance (higher value).

8.3.12 Fish

The results of the various fisheries surveys carried out between the 22 and 30 September 2015, along with the findings of the desktop study, are summarised below. The locations of sampling points/areas are shown on **Figure 8.11.1**, with the full results (including the macro-invertebrate species lists) provided in **Appendix A.8.17**. Fish species are protected under the Fisheries Acts and by fishing by-laws.

[48] Records from the National Biodiversity Centre's online database. For full details of the desk review, refer to **Appendix 8.18**.

Atlantic salmon, Sea lamprey and the Brook lamprey are listed on Annex II of the EU Habitats Directive.

Sruthán na Líbeirtí

Sruthán na Líbeirtí was described during the fisheries habitat survey as a seasonal stream having moderate quality, semi-natural salmonid and European eel *Anguilla anguilla* habitat in the lower reaches; the electrofishing survey recorded small numbers of European eel in the lower reaches. Water quality in Sruthán na Líbeirtí was assessed as being moderately polluted (Q3[49]).

In terms of its fisheries value, Sruthán na Líbeirtí is valued as being of Local Importance (lower value).

Trusky Stream

The upper part of the Trusky Stream, where it is crossed by the proposed road development, was described during the fisheries habitat survey as a seasonal stream with some moderate semi-natural salmonid habitat; although the electrofishing survey did not record any fish species present. The lower reaches however, were described as having Brown trout *Salmo trutta* spawning habitat and good quality nursery habitat for European eel elver and juvenile Flounder *Platichthys flesus*. Fish species recorded during the electrofishing were Brown trout, European eel, Flounder and Three-spined stickleback *Gasterosteus aculeatus*. Water quality in the Trusky Stream was assessed as being moderately polluted (Q3).

In terms of its fisheries value, the upper reaches of the Trusky Stream is valued as being of Local Importance (lower value); the lower reaches, as Local Importance (higher value).

Bearna Stream

The Bearna Stream was considered excellent quality salmonid spawning and nursery habitat, and European eel habitat. The electrofishing survey recorded both Brown trout and European eel. Water quality in the Bearna Stream was assessed as being unpolluted (Q4).

The tributary of the Bearna Stream was described as a seasonal stream with some moderate semi-natural salmonid and eel habitat; although the electrofishing survey did not record any fish species present. Water quality in the Bearna Stream tributary was assessed as being moderately polluted (Q3).

In terms of its fisheries value, the Bearna Stream was valued as being of Local Importance (higher value). The seasonal unnamed tributary is valued as being of Local Importance (lower value).

Tonabrocky Stream

The upper reaches, in the vicinity of the proposed road development, had poor quality fisheries habitat being predominantly a dry drainage channel with localised pockets of water.

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[49] After Toner *et al.*, 2005: Q5, Q4-5 and Q4 = Unpolluted, Class A; Q3-4 = Slightly polluted, Class B; Q3 or Q2/3 = Moderately polluted Class C; and, Q2, Q1/2 or Q1 = Seriously polluted Class D.

The lower reaches of the Tonabrocky Stream are considered excellent quality salmonid and eel habitat, including salmonid spawning habitat. The electrofishing survey recorded Brown trout. Electrofishing surveys carried out by Inland Fisheries Ireland (IFI) in 2008 recorded Atlantic salmon parr (*Salmo salar*), Brown trout, Sea trout smolts and European eel. IFI have also recorded Sea trout spawning in the lower reaches of the stream. Water quality in the Tonabrocky Stream was assessed as being unpolluted (Q4).

In terms of its fisheries value, the upper reaches of the Tonabrocky Stream is valued as being of Local Importance (lower value); the lower reaches, as Local Importance (higher value).

Knocknacarra Stream

The upper reaches of the Knocknacarra Stream were largely seasonal ditches with little or no fisheries value; large sections of the lower reaches are culverted. That tidal section of the stream, between the culvert and the estuary, are important as a transitional nursery habitat for estuarine fish and European eel, Grey mullet *Chelon labrosus*, Sand goby *Pomatoschistus minutes* and Flounder were recorded there during the electrofishing survey. Water quality in the Knocknacarra Stream was assessed as being moderately polluted (Q3).

In terms of its fisheries value, the upper reaches of the Knocknacarra Stream were valued as being of Local Importance (lower value); the lower reaches, at the estuary, as Local Importance (higher value).

River Corrib

The River Corrib is an important salmonid watercourse, supporting both Atlantic salmon and Brown trout, and is a designated salmonid watercourse under the European Communities (Quality of Salmonid Waters) Regulations, 1988. The River Corrib system is also designated under the Habitats Directive as a candidate Special Area of Conservation for Atlantic salmon, Sea lamprey *Petromyzon marinus* and Brook lamprey *Lampetra planeri*—Lough Corrib cSAC. The River Corrib is also an important catchment for the European eel *Anguilla anguilla*. Water quality in the lower reaches of the River Corrib is classified as unpolluted (Q4) by the EPA (sampled at the Salmon Weir - http://gis.epa.ie/Envision).

In terms of its fisheries value, the River Corrib was valued as being of International Importance.

Terryland River

The channel of the Terryland River is highly modified in parts, and showing signs of organic pollution, which limits its fisheries value. European eel were the only fish species recorded during the electrofishing surveys. Water quality in the Terryland River was assessed as being moderately polluted (Q2-3).

In terms of its fisheries value, the Terryland River was valued as being of Local Importance (lower value).

Coolagh Lakes

The Coolagh lakes were of some importance for coarse fish species. Fyke netting recorded Perch *Perca fluviatilis*, Roach *Rutilus rutilus* and European eel. The spring feed stream supplying the lakes was electrofished but no fish species were recorded. The Coolagh Lakes does not have a Water Framework Directive water quality status assigned to it.

In terms of their fisheries value, the Coolagh Lakes were valued as being of Local Importance (lower value).

Ballindooley Lough

Ballindooley Lough was considered to be an excellent coarse fishery with the fyke netting survey recording Pike *Esox lucius*, Perch, Rudd *Scardinius erythropthalmus* and Tench *Tinca tinca*. Ballindooley Lough does not have a Water Framework Directive water quality status assigned to it.

In terms of its fisheries value, Ballindooley Lough was valued as being of Local Importance (higher value).

Corrib Estuary and Galway Bay

The Corrib Estuary and Galway Bay are important transitional and marine fisheries habitat, supporting a range of fish species (The Central and Regional Fisheries Boards, 2009). The Corrib Estuary and Galway Bay are also designated under the Habitats Directive as a candidate Special Area of Conservation for Atlantic salmon — Galway Bay Complex cSAC. The transitional waters of the Corrib Estuary and the coastal waters of Galway Bay are classified by the EPA as unpolluted (http://gis.epa.ie/Envision).

In terms of its fisheries value, Galway Bay was valued as being of International Importance.

8.3.13 Local Biodiversity Areas

The local biodiversity areas include within the *Galway City Development Plan 2017–2023* and the most recent draft of the *Galway City Biodiversity Action Plan 2014-2024*, are derived from habitat mapping carried out in 2004. The results of the biodiversity surveys carried out since 2013, in the preparation of this assessment, have highlighted many other areas that would be considered to be locally important biodiversity areas. In many cases, these would encompass greater areas than that considered in the draft *Galway City Biodiversity Action Plan 2014-2024* given that the current survey areas extend beyond the city boundary. The locations of the biodiversity surveys and receptors across the local area are shown on **Figures 8.1 – 8.22** and described under the various sections above.

For the purposes of this assessment, the following biodiversity areas are considered; which include the local biodiversity areas from the draft *Galway City Biodiversity Action Plan 2014-2024*:

- The Coast Road (R336) to the N59 Moycullen Road (which includes the Cappagh – Ballymoneen and the Ballagh – Barnacranny Hill local biodiversity areas from the draft *Galway City Biodiversity Action Plan 2014-2024*)

  This local biodiversity area encompasses a mosaic of peatland habitats extending from near the coastline west of Bearna across to the N69 Moycullen Road – the peatland areas form part of a larger expanse of peatland habitat that extend off to the north-west, into the Connemara Bogs cSAC. In terms of habitats, it includes the Annex I habitats Wet heath, Dry heath, *Molinia* meadows and Blanket bog, amongst large areas of scrub, bracken, acid and wet grasslands, along with fens and upland/eroding streams. These habitats in turn support a diverse range of fauna species including: bats, Otter, Badger, the Marsh fritillary butterfly, breeding birds, wintering birds (including species listed as SCIs of the local SPA sites), amphibians, reptiles and fish species. Parts of this site lie within Moycullen Bogs NHA

- Rusheen Bay – Bearna Woods – Illaunafamona

  This local biodiversity area is described in the draft *Galway City Biodiversity Action Plan 2014*-2024 as follows "It incorporates several types of shoreline including glacial cliffs, gravel banks, rocky shore, sandy shore, muddy sand and saltmarsh. It also has several types of woodland in Barna Woods together with various semi-natural grassland types between Silver Strand and Gentian Hill. The coast is very indented with a number of sheltered feeding and roosting areas for significant numbers of wintering birds. The dynamic complex of shingle bars and saltmarsh at Illaunafamona is included in this area." This area lies within Galway Bay Complex cSAC and Inner Galway Bay SPA

- The River Corrib and the Coolagh lakes (which includes the River Corrib and adjoining wetlands local biodiversity areas from the draft *Galway City Biodiversity Action Plan 2014-2024*)

  This local biodiversity area supports a range of aquatic and wetland habitats ranging from rivers and lakes to reed swamp, wet woodland, marsh, wet grassland, fens and heath. These include a diverse range of Annex I habitats including Hard water lakes, Wet heath, *Molinia* meadow, *Cladium* fen, Hydrophilous tall herb habitat, Alkaline fen, Transition mire and Residual alluvial forests. Drier areas within this habitat complex support the Limestone pavement and Calcareous grassland Annex I habitat types. These habitats in turn support a diverse range of fauna species including: bats, Otter, Badger, breeding birds, wintering birds (including species listed as SCIs of the local SPA sites), molluscs, amphibians and fish species. This area includes part of Lough Corrib cSAC and part of Lough Corrib pNHA

- Menlough to Coolough Hill (including Lackagh Quarry)

  This local biodiversity area comprises a mosaic of semi-natural woodland, broadleaved woodland, exposed limestone rock, scrub and semi-natural grasslands, and a quarry site. This includes a range of Annex I habitat types, including: Limestone pavement, Calcareous grassland, Turloughs and Petrifying springs. These habitats in turn support a diverse range of fauna species including: bats (including a Lesser horseshoe bat maternity and hibernation roost), Otter, Badger and breeding birds (including a Barn owl nest site). This area includes part of Lough Corrib cSAC and part of Lough Corrib pNHA

- Ballindooley – Castlegar (which is linked to the River Corrib by the Terryland River valley)

  This local biodiversity area comprises a mosaic of wetland habitats associated with Ballindooley Lough (including reed swamp, wet grassland, fen and wet woodland) and areas of semi-natural woodland and exposed limestone rock. This includes a diverse range of Annex I habitat types including Hard water lakes, Alkaline fen, *Cladium* fen, Residual alluvial forests and Limestone pavement. These habitats in turn support a diverse range of fauna species including: bats, Badger, breeding birds, wintering birds (including species listed as SCIs of the local SPA sites), amphibians and fish species

- Galway Racecourse, Ballybrit

  Although primarily consisting of amenity grassland around the margins, the centre of the racecourse supports semi-natural grasslands, and the Marsh fritillary butterfly was recorded here in 2014

- Doughiska

  This biodiversity area comprises a mosaic of semi-natural grassland and exposed limestone rock, with some semi-natural woodland cover and scrub patches, amongst improved agricultural fields. In places the grassland habitats correspond with the Annex I Calcareous grassland habitat type, and the exposed or wooded limestone rock with Annex I Limestone pavement.

- Galway Bay (which includes the Mutton Island and Nearby Shoreline local biodiversity areas from the draft *Galway City Biodiversity Action Plan 2014-2024*).

  Galway Bay Complex cSAC and Inner Galway bay SPA lie within this biodiversity area. This biodiversity area includes a diverse range of shoreline, transitional, estuarine and marine habitats which in turn support a rich species assemblage. The Annex I habitats present include Large shallow inlets and bays, associated with which are Reefs, Tidal mudflats, Lagoons, Salicornia mud, Perennial vegetation of stony banks and Atlantic salt meadows. These habitats support the SCI bird species of Inner Galway bay SPA, providing nesting, foraging and roosting sites which include open water, intertidal and terrestrial habitats. The habitats within Galway Bay also support a diverse range of invertebrate and plant communities (marine and intertidal) and fish species, along with Otter, Harbour seal and cetaceans

8.3.14 Summary Ecological Valuation and Identification of Key Ecological Receptors

Table 8.26 below summarises the ecological evaluation of all receptors taking into consideration legal protection, conservation status and local abundance. Key Ecological Receptors (KERs) are identified in blue in the table. Species, habitats and features not qualifying as KERs are not subjected to impact assessment in line with current best practice of assessing the impacts on what are determined to be important ecological or biodiversity features: CIEEM and TII guidelines (CIEEM, 2016 and National Roads Authority, 2009).

All designated areas for nature conservation that lie within the ZoI of the proposed road development are considered to be KERs given that they are sites selected specifically for biodiversity conservation. Those designated areas for nature conservation that lie beyond the ZoI of the proposed road development are not considered to be at risk of impact and are therefore, not considered to be KERs.

In almost all cases, habitat and species valued as being of local importance (higher value), or higher, are considered to be KERs as they are important contributors to the local biodiversity resource and are of conservation concern, at least locally. However, some of the higher biodiversity value habitats and species included in **Table 8.26** below are not considered as KERs because, although they are present within the wider scheme study area, they lie beyond the ZoI of the proposed road development (as noted in the table below) and are therefore not at risk of being affected during construction or operational phases of the proposed road development.

Habitats valued as being of a local importance (lower value) are not considered to be KERs in this assessment. This is not to say that they are of no biodiversity value, but that impacts on these habitat types in their local context are not likely to result in a significant effect on biodiversity. It should be noted that this relates to the impact on the habitat itself as distinct from considering the role these habitat types play in supporting KER species – impacts of the proposed road development in that sense are captured and assessed under the relevant species' headings in **Section 8.5**.

These lower biodiversity value habitats include built or artificially created habitats, transient habitats as a result of disturbance, or those that have been highly anthropogenically modified (e.g. BC3, BL3, ED2, ED3, ED4, FL8, GA1, GA2, WS3, WS5). These habitat types tend to be associated with residential, commercial or industrial development, roads and highly managed amenity areas. It also includes grassland habitats that are relatively species poor and bracken, which is considered to be a problem species in terms of biodiversity for many habitat types.

In some cases, local importance (lower value) habitat can be associated with, or develop into, higher value habitats and where this is the case it is captured in valuing and considering whether a particular habitat type is a KER for this assessment. One example of this is the habitat Exposed calcareous rock (ER2). As a quarry wall feature it is considered a local importance (lower value) habitat type. In many cases it can be associated with the Annex I habitat Limestone pavement and is valued accordingly. Limestone quarry walls can also support calcareous springs (or the priority Annex I habitat Petrifying springs) and where this is the case the spring features are considered and valued separately in **Table 8.26** below.

Non-native invasive plant species are not considered as KERs, as they can result in negative effects on biodiversity and it is in that context they are included within the impact assessment.

The local biodiversity areas are, by definition, important locally. However, they support a range of habitats and species that are valued individually below; with the valuations ranging from local importance (e.g. spoil and bare ground) through to internationally important (e.g. priority Annex I habitats). Therefore, they are considered to be KERs but are not given an ecological valuation separate from the biodiversity receptors presented below and assessed in this chapter.

Table 8.26: Ecological Evaluation and Identification of KERs[50]

Ecological Receptor	Ecological Valuation	KER
Designated Areas for Nature Conservation		
Lough Corrib cSAC	International	Yes
Galway Bay Complex cSAC	International	Yes
Lough Corrib SPA	International	Yes
Inner Galway Bay SPA	International	Yes
Moycullen Bogs NHA	National	Yes
Lough Corrib pNHA	International#	Yes
Galway Bay Complex pNHA	International†	Yes
Other designated areas for nature conservation	International - National	No, as beyond the ZoI of the proposed road development (see NIS for more detailed discussion in relation to European sites – cSACs and SPAs)
Habitats (outside of designated areas for nature conservation)		
Flower beds and borders (BC4)	Local Importance (Lower Value)	No
Buildings and artificial surfaces (BL3)	Local Importance (Lower Value)	No
Spoil and bare ground (ED2)	Local Importance (Lower Value)	No
Recolonising bare ground (ED3)	Local Importance (Lower Value)	No
Active quarries and mines (ED4)	Local Importance (Lower Value)	No
Exposed siliceous rock (ER1)	Local Importance (Lower Value)	No
Exposed calcareous rock (ER2)		
Limestone pavement [*8240]	International Importance	Yes
Quarry walls	Local Importance (Lower Value)	No

[50] KERs are highlighted blue

Ecological Receptor	Ecological Valuation	KER
Limestone/marl lakes (FL3)		
Hard water lakes [3140]	National Importance	Yes
Mesotrophic lakes (FL4)		
Part of Ballindooley complex	County Importance[51]	Yes
Eutrophic lakes (FL5)		
Part of Ballindooley complex	County Importance[52]	Yes
Turloughs (FL6)		
Turloughs [*3180]	International Importance	Yes
Other artificial lakes and ponds (FL8)	Local Importance (Lower Value)	No
Calcareous springs (FP1) Priority		
Petrifying springs [*7220]	International Importance	Yes
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Reed and large sedge swamps (FS1)		
Cladium fen [*7210]	International Importance	Yes
Hydrophilous tall herb [6430]	National Importance	Yes
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Tall-herb swamps (FS2)		
Cladium fen [*7210]/Hydrophilous tall herb [6430]	International/National Importance	Yes
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Eroding/upland rivers (FW1)	Local Importance (Higher Value)	Yes
Depositing/lowland rivers (FW2)		
River Corrib	International Importance	Yes
Terryland River	Local Importance (Higher Value)	Yes
Drainage ditches (FW4)	Local Importance (Higher Value)	Yes
Improved agricultural grassland (GA1)	Local Importance (Lower Value)	No
Amenity grassland (improved) (GA2)	Local Importance (Lower Value)	No
Marsh (GM1)	Local Importance (Higher Value)	Yes
Dry calcareous and neutral grassland (GS1)		
Calcareous grassland [*6210/6210]	International/National Importance	Yes
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Non-Annex I habitat type	Local Importance (Lower Value)	No
Dry meadows and grassy verges (GS2)		
Lowland hay meadows [6510]	National Importance	No, as not within ZoI of the proposed road development
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Non-Annex I habitat type	Local Importance (Lower Value)	No

[51] On the basis that it forms part of the wetland complex at Ballindooley Lough
[52] On the basis that it forms part of the wetland complex at Ballindooley Lough

Ecological Receptor	Ecological Valuation	KER
Dry-humid acid grassland (GS3)		
Species rich *Nardus* upland grassland [*6230]	National Importance	No, as not within ZoI of the proposed road development
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Non-Annex I habitat type	Local Importance (Lower Value)	No
Wet grassland (GS4)		
Molinia meadow [6410]	National Importance	Yes
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Non-Annex I habitat type	Local Importance (Lower Value)	No
Dense bracken (HD1)	Local Importance (Lower Value)	No
Dry siliceous heath (HH1)		
Dry heath [4030]	National Importance	Yes
Dry calcareous heath (HH2)		
Dry heath [4030]	National Importance	No, as not within ZoI of the proposed road development
Wet heath (HH3)		
Wet heath [4010]	National Importance	Yes
Rich fen and flush (PF1)		
Alkaline fens [7230]/*Cladium* fen [*7210]	International Importance	Yes
Non-Annex I habitat type	County Importance	Yes
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Poor fen and flush (PF2)		
Non-Annex I habitat type	County Importance	No, as not within ZoI of the proposed road development
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Residential	Local Importance (Lower Value)	No
(Mixed) broadleaved woodland (WD1)	Local Importance (Higher Value)	Yes
Mixed broadleaved/conifer woodland (WD2)	Local Importance (Higher Value)	Yes
(Mixed) conifer woodland (WD3)	Local Importance (Higher Value)	Yes
Scattered trees and parkland (WD5)	Local Importance (Lower Value)	No, as not within ZoI of the proposed road development
Hedgerows (WL1)	Local Importance (Higher Value)	Yes
Treelines (WL2)	Local Importance (Higher Value)	Yes
Oak-ash-hazel woodland (WN2)		
Limestone pavement [*8240]	International Importance	Yes
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Wet willow-alder-ash woodland (WN6)	International Importance	Yes

Ecological Receptor	Ecological Valuation	KER
Residual alluvial forest [*91E0]		
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Scrub (WS1)		Yes
Limestone pavement [*8240]	International Importance	
Non-Annex I habitat type	Local Importance (Higher Value)	Yes
Immature woodland (WS2)	Local Importance (Higher Value)	No, as not within ZoI of the proposed road development
Ornamental/non-native shrub (WS3)	Local Importance (Lower Value)	No
Recently-felled woodland (WS5)	Local Importance (Lower Value)	No
Flora Species		
FPO listed species	n/a	No, as not within ZoI of the proposed road development
Non-native invasive plant species	n/a	No
Fauna Species		
Otter	International Importance	Yes
Bats		
Lesser horseshoe bat	National Importance	Yes
All other bat species	Local Importance (Higher Value)	Yes
Badger	Local Importance (Higher Value)	Yes
Other mammal species protected under the Wildlife Acts	Local Importance (Higher Value)	Yes
White-clawed crayfish	n/a	No, as not within ZoI of the proposed road development
Freshwater pearl mussel	International Importance[53]	Yes
Vertigo antivertigo	Local Importance (Higher Value)	Yes
Marsh fritillary butterfly	County Importance	Yes
SCI bird species	International	Yes
Barn owl	County Importance	Yes
Peregrine falcon	County Importance	Yes
All other Red listed bird species (non-SCI breeding populations)	Local Importance (Higher Value)	Yes
All other Amber listed bird species (non-SCI breeding populations)	Local Importance (Higher Value)	Yes
Any other Green listed bird species (non-SCI breeding populations)	Local Importance (Higher Value)	Yes

[53] Assessed in the NIS in the context of the qualifying interest population of Lough Corrib cSAC in the Owenriff River

Ecological Receptor	Ecological Valuation	KER
All other wintering bird species (non-SCI)	Local Importance (Higher Value)	Yes
Smooth newt	Local Importance (Higher Value)	Yes
Common frog	Local Importance (Higher Value)	Yes
Common lizard	Local Importance (Higher Value)	Yes
Atlantic salmon	International Importance	Yes
European eel	International	Yes
All other fish species recorded	Local Importance (Higher Value)	Yes
Local Biodiversity Areas		
Local biodiversity areas	The value of the biodiversity receptors recorded across the local biodiversity areas, in the vicinity of the proposed road development, range from Local Importance (Lower Value) to Internationally Important	Yes
The Coast Road (R336) to the N59 Moycullen Road	Local Importance (Lower Value) to Internationally Important includes Moycullen Bogs NHA	Yes
Rusheen Bay – Barna Woods – Illaunafamona	Local Importance (Lower Value) to Internationally Important includes Galway Bay Complex cSAC and Inner Galway Bay SPA	Yes
The River Corrib and the Coolagh Lakes	Local Importance (Lower Value) to Internationally Important includes Lough Corrib cSAC/SPA/pNHA	Yes
Menlough to Coolough Hill (including Lackagh Quarry)	Local Importance (Lower Value) to Internationally Important includes Lough Corrib cSAC	Yes
Ballindooley – Castlegar	Local Importance (Lower Value) to Internationally Important	Yes
Galway Racecourse, Ballybrit	Local Importance (Lower Value) to Internationally Important	Yes
Doughiska	Local Importance (Lower Value) to Internationally Important	Yes
Galway Bay	Local Importance (Lower Value) to Internationally Important includes Galway Bay Complex cSAC and Inner Galway Bay SPA	Yes

Generally encompassed within Lough Corrib cSAC

† Generally encompassed within Galway Bay Complex cSAC

8.4 Characteristics of the Proposed Road Development

A detailed description of the proposed road development and construction activities are provided in **Chapter 5, Description of Proposed Road Development** and **Chapter 7, Construction Activities**.

The main characteristics of the proposed road development of relevance to the ecological assessment are outlined under construction and operation phases in the following.

8.4.1 Construction Phase

The main characteristics of the construction stage of the proposed road development that have potential for ecological impact are:

- Site preparation and clearance, including ground investigations, archaeological test trenching and fencing
- Removal of properties, boundaries, amenities
- Earthwork activity, including removal of topsoil, general earthworks and operation of construction traffic
- Construction of significant earthworks, including cuttings and rock cuttings (< 3m deep) and embankments (< 3m high)
- Construction of the new road, link roads and associated local road re-alignments, including provision of noise barriers, lighting, gantries signage, *etc*.
- Construction of new structures, including under and overbridges, culverts, a c.650m long bridge crossing of the River Corrib and its valley, a c.310m length of viaduct, and 2 separate sections of tunnel – one of c.270m length at Lackagh Quarry, and a second of c.240m length at Galway Racecourse.

8.4.2 Operational Phase

The main characteristics of the operation stage of the proposed road development that have potential for ecological impact are:

- The presence and operation (traffic) of the road
- The presence of additional roadside lighting

8.5 Evaluation of Impacts

8.5.1 Introduction

The following section presents the assessment of impacts on biodiversity within the Zone of Influence (ZoI) of the proposed road development. As outlined in **Section 8.2.5**, this is focussed on the Key Ecological Receptors (KERs) identified in **Section 8.3.14**. This includes consideration of the Do-Nothing impact – i.e. the existing trends with the potential to affect biodiversity in the absence of the proposed road development.

8.5.2 Do Nothing Impact

Existing trends

Across the study area, as evidenced from a review of historical orthophotos and the *Galway City Habitats Inventory* dataset (Natura, 2005), there have been changes to the biodiversity baseline in recent decades: the most significant change likely to have been habitat loss to development and habitat degradation impacts, primarily as a result of either agricultural intensification/reclamation or scrub encroachment through agricultural abandonment. The existing road network has limited drainage control or pollution control measures and, with increasing traffic numbers, may have had some effects on biodiversity in the receiving environment.

There have been habitat losses to development in the area between the Cappagh and Ballymoneen Roads, and along the network of local roads which extend north from the R336 coast road, e.g. Na Foraí Maola Road, Troscaigh Road, Bearna to Moycullen Road LL1321 and the Aille Road L5384. In some cases areas of peatland habitats have likely been affected. Where agricultural management has been reduced, or has been abandoned altogether, fields are becoming overgrown by gorse, bramble scrub and/or dense bracken cover. In places this is encroaching upon peatland habitat. This is most evident in the western part of the study area in those isolated peatland habitat blocks set between the network of local roads and the associated ribbon-type residential development. Sections of watercourses have been culverted as a consequence of development; the most extensive of which are associated with the Knocknacarra Stream. Coolough, Ardaun and Doughiska have seen losses of Limestone pavement [*8240] and most likely also areas of semi-natural grassland habitat [e.g. 6210] since 1994 as a result of road development, residential and industrial development, and agricultural land use change/improvement. Quarrying activities in the local area have resulted in the loss of limestone pavement and potentially also areas of calcareous grassland habitats since the year 2000. Scrub encroachment has also reduced the extent of exposed limestone pavement habitat area at Menlough, in the area between Bóthar Nua and Seanbóthar.

There is little historical baseline data to establish trends for fauna species locally although the habitat changes that have occurred may have had some effects, both positive and negative, on fauna biodiversity and distributions locally.

Likely Future Trends

As the full extent of the proposed road development passes through lands zoned under either the Galway City Council Development Plan 2017-2023, the Galway County Council Development Plan 2015-2021, the Bearna Local Area Plan 2007-2017, or the Ardaun Local Area Plan 2018-2024, the current land use zonings provide the best indication of what the future short to medium-term biodiversity trends might be, as they will influence and direct development in the surrounding area. It is also likely that traffic numbers will continue to increase on a road network with limited drainage control or pollution control measures, which may have effects on biodiversity receptors in the receiving environment.

The area around Sruthán na Líbeirtí is zoned for environmental management, as is the Trusky Stream corridor and the coastline – this zoning aims to protect areas of high biodiversity and promote sustainable development. An area east of Sruthán na Líbeirtí, and to the west of Bearna Woods, is zoned green wedge with the area in between zoned as rural fringe, these zonings limit the types of future development on those lands.

The area between Bearna Woods and the River Corrib is a mix of residential, amenity, agri-amenity and agriculture zonings. The lands between the proposed road development and the Cappagh Road are predominantly zoned residential, with some amenity and industrially zoned areas. Similarly, lands around NUIG and the N59 Moycullen Road are a mix of residential and amenity zonings. Sitting between both these areas is a large expanse of lands zoned for agriculture – which includes part of the Moycullen Bogs NHA at Tonabrocky. A second area at na hAille comprises both agricultural and agri-amenity land use zoning.

Between Menlough and the N83 Tuam Road, lands to the north of the proposed road development are largely zoned agricultural (in line with their current use) with a band of agri-amenity zoned lands extending from Menlough Village to Galway City along the east bank of the River Corrib. There is a small pocket of light-industrial and residential zoned lands along the N84 Headford Road, residential along the N83 Tuam Road and areas of light residential zoning at Menlough and adjacent to the southern end of Lackagh Quarry.

Aside from Galway Racecourse (which is zoned as an amenity area), lands between the N83 Tuam Road and the R339 are zoned for industrial, residential or commercial uses.

The majority of lands adjoining the proposed road development at Doughiska (east of the existing N6 and between the R446 and the R449) fall within what is the Ardaun Local Area Plan boundary. The *Ardaun Local Area Plan 2018-2026* includes large areas zoned for development. West of the existing N6 in this area is largely zoned for residential development.

Current biodiversity trends are likely to continue in areas zoned for environmental management, green wedge, rural fringe or agriculture with some limited development and land use change likely. Amenity or agri-amenity zoned areas are likely to come under some level of increased pressure from developing and constructing additional recreational infrastructure and through increased human presence and disturbance. Areas zoned for residential, commercial or industrial purposes are likely to have the greatest effects on local biodiversity through habitat loss and/or modifications (potentially affecting Annex I and other semi-natural habitats) and any associated effects on fauna species.

However, any effects on biodiversity are likely to be moderated by the environmental protective policies in both the *Galway City Council Development Plan 2017-2023*, *Galway County Development Plan 2015-2021*, the *Bearna Local Area Plan 2007-2017*, and the *Ardaun Local Area Plan 2018-2024*.

The interaction between the existing trends, future trends, and other plans or projects with the proposed road development are considered and assessed further in the cumulative impacts section (Section 8.9).

8.5.3 Designated Areas for Nature Conservation

This section describes and assesses the potential for the proposed road development to result in likely significant effects on designated areas for nature conservation at cSACs/SACs, SPAs, NHAs or pNHAs. In the context of European sites this is focussed on the habitats and species for which the sites are selected (QIs for cSACs and SCIs for SPAs) and the conservation objectives supporting their conservation status in each site. This assessment is directly related to the assessment methodology for European sites required under the Habitats Directive, which is presented in the Natura Impact Statement (NIS) for the proposed road development.

In the case of NHAs and pNHAs the assessment considers whether the integrity[54] of any such site would be affected by the proposed road development with reference to the ecological features for which the site is designated, or is proposed.

8.5.3.1 European Sites

In the context of assessing whether the proposed road development is likely to result in an impact on the integrity of any European sites, the tests and assessment presented in the NIS fulfil this role. The NIS considers whether the proposed road development will affect the conservation objectives supporting the favourable conservation condition of the European site's QIs/SCIs and as a result presents an assessment of whether the integrity of any European sites would be affected – i.e. if the proposed road development would adversely affect on the integrity of a European site, this would constitute a likely significant effect in the context of the EIA Directive.

The nature and scale of the proposed road development, the identified potential impacts and their relationship to European sites were considered in order to determine which European sites were within the ZoI of the proposed road development, in view of best scientific knowledge and in view of conservation objectives, and therefore potentially at risk of the proposed road development affecting their conservation objectives. The potential impacts associated with the proposed road development are discussed below in relation to those European sites within its ZoI (see also Section 6 of the NIS).

[54] Refer to **Section 8.2.5** for definition and impact assessment methodology

The Zone of Influence (ZoI) is a distance within which the proposed works could potentially affect the conservation condition of QI habitats or QI/SCI species of a European site.

The mechanism to define the ZoI is summarised as follows:

- Consider the nature, size and location of the proposed road development
- Consider the sensitivities of the ecological receptors
- Identify impact sources and pathways
- Determine the ZoI based on the extent of the impact

Considering the ZoI, in the absence of mitigation measures, the proposed road development was assessed as having the potential to adversely affect the integrity of the following four European sites (refer to Section 8 of the NIS):

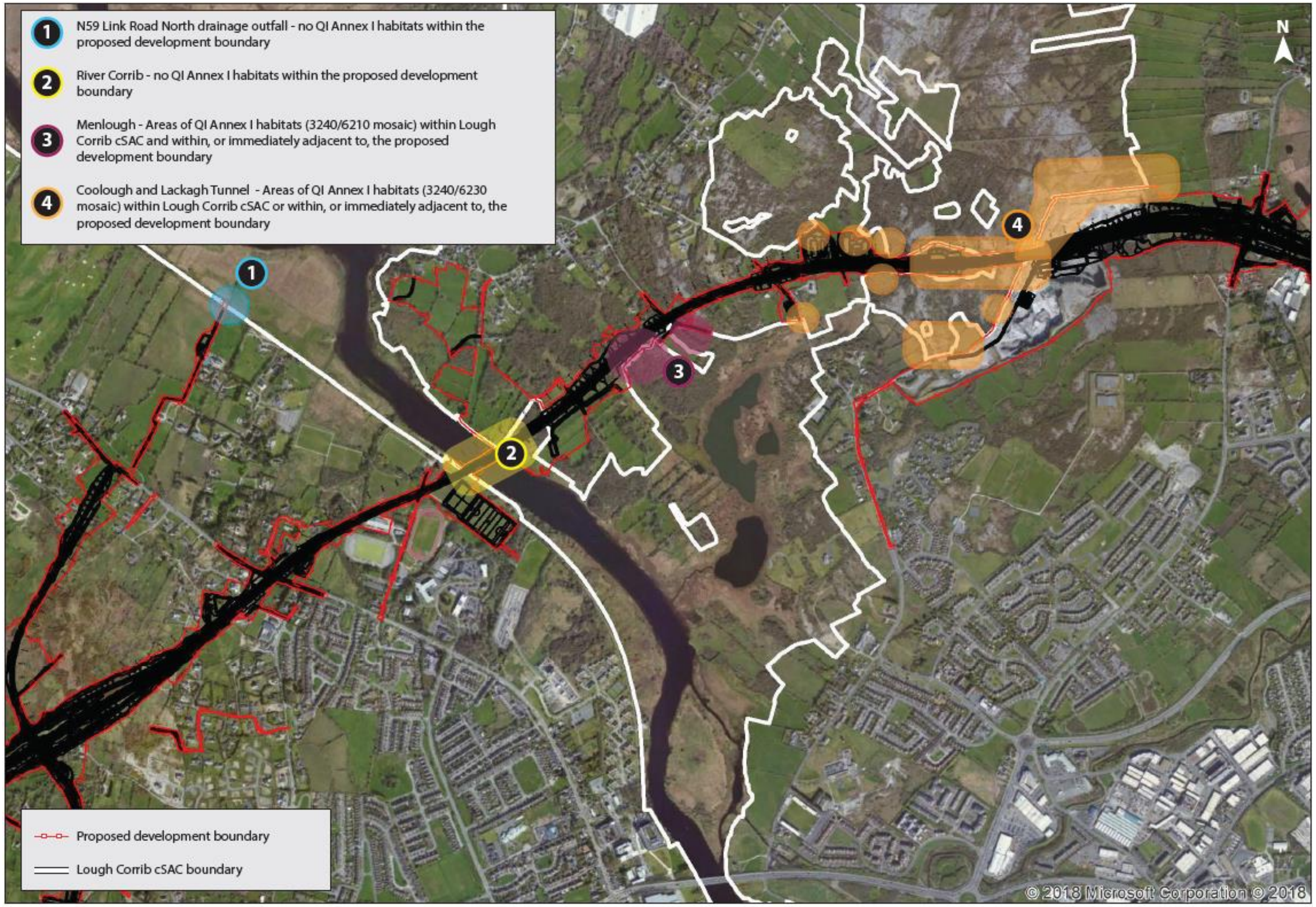
- Lough Corrib cSAC
- Lough Corrib SPA
- Galway Bay Complex cSAC
- Inner Galway Bay SPA

The locations of these European sites relative to the proposed road development, and the predicted ZoI, are shown on **Figure 8.12.1**.

Lough Corrib cSAC

The proposed road development and its boundary overlaps with, i.e. traverses through or adjacent to one Euroepean site, namely Lough Corrib cSAC at four locations: at the termination of the proposed drainage outfall from the N59 Link Road North at Kentfield; at the site of the proposed River Corrib Bridge between Dangan and Menlough; to the west of the Coolagh Lakes (Ch. 9+850 to Ch. 10+100); and, to the west and north of Lackagh Quarry where the proposed road development will consist of a tunnel (Lackagh Tunnel) and approach road infrastructure. Refer to **Plate 8.1** below. The proposed road development also traverses a number of groundwater bodies that support groundwater dependant wetland habitats within European sites and traverses a number of watercourses that lie within or drain to a Euorpean site.

Plate 8.1: Proposed Road Development overlap with European sites



The potential impacts to the Lough Corrib cSAC are discussed below under the following headings:

- Habitat loss
- Habitat degradation as a result of tunnelling/excavation associated with construction of the Lackagh Tunnel
- Habitat degradation as a result of hydrogeological impacts
- Habitat degradation as a result of hydrology impacts
- Habitat degradation as a result of air quality impacts
- Habitat degradation as a result of introducing/spreading non-native invasive plant species
- Mortality risk from construction works and road traffic

Habitat loss

There are no areas of QI Annex I habitats within Lough Corrib cSAC that lie beneath the footprint of the proposed road development or will be directly impacted. Neither will the proposed road development result in the direct loss of any habitats that support the QI habitats that are present in Lough Corrib cSAC. However, within Lough Corrib cSAC there are areas of the QI habitats Limestone pavement [*8240] and Calcareous grassland [6210] that lie within the proposed development boundary yet outside of the footprint of the proposed road developmnet which could be directly impacted, if not protected from construction works. With respect to these QI habitats and their conservation objectives, habitat loss could affect the habitat area of Calcareous grassland and Limestone pavement within Lough Corrib cSAC, and could also affect the distribution of these habitat types within the European site.

Habitat degradation as a result of tunnelling/excavations associated with construction of the Lackagh Tunnel

Construction of the Lackagh Tunnel could affect the structural integrity of the rock mass above, and result in damage to, or loss of, the QI Annex I habitats Limestone pavement and Calcareous grassland within Lough Corrib cSAC at the surfacce. With respect to these QI habitats and their conservation objectives, habitat loss could affect the habitat area of Calcareous grassland and Limestone pavement within Lough Corrib cSAC, and could also affect the distribution of these habitat types within the European site.

Habitat degradation as a result of hydrogeological impacts

The construction of the Lackagh Tunnel and the piers for Menlough Viaduct have the potential to affect the existing groundwater regime locally within the Lough Corrib Fen 1 (Menlough) GWB, the Lough Corrib Fen 1 (Lackagh) GWB and the Clare-Corrib GWB. This in turn could affect the groundwater supply to the Western and Eastern Coolagh Springs that contributes groundwater to the Coolagh Lakes and the associated QI wetland habitats in Lough Corrib cSAC[55]. With respect to the QI habitats and species and their conservation objectives, this impact could affect:

- The natural hydrological regime (e.g. water levels and flooding) and water chemistry
- The area, local distribution and condition of groundwater dependant wetland habitat
- The vegetation composition, diversity, structure and distribution, the abundance and distribution of typical and locally distinctive species associated with QI habitats

The drainage design of the proposed road development avoids any long-term impacts to the existing groundwater regime that could affect any of the groundwater dependant habitats in Lough Corrib cSAC. However, mitigation measures are required in the event that any groundwater conduits are encountered during construction and to ensure that karst features do not affect the functioning of the infiltration basins during operation.

Habitat degradation as a result of hydrological impacts

The proposed road development could affect surface water quality in the receiving environment which supports aquatic/wetland habitats within Lough Corrib cSAC. These habitats in turn support the QI aquatic species present: Otter, Atlantic salmon, Sea lamprey and Brook lamprey. With respect to the QI habitats and species and their conservation objectives, this impact could affect:

- Habitat area, distribution and condition/quality, along with vegetation composition, diversity, structure and distribution, and the abundance and distribution of typical and locally distinctive species
- Fish populations (including Atlantic salmon) through affecting fish numbers, population structure and habitat quality, which can also affect recruitment in the Freshwater pearl mussel populations upstream
- Otter abundance and distribution, prey abundance and the availability of holt and couch sites

Habitat degradation as a result of air quality impacts

Dust deposition arising from construction activities could locally affect the extent, diversity, and vegetation composition or structure of habitats within Lough Corrib cSAC that are present in the vicinity of the proposed road development.

[55] The Western Coolagh Spring is the main contributor to the Coolagh Lakes with a substantial groundwater supply through the underlying limestone bedrock. The Eastern Coolagh Spring only contributes a very small amount of surface water flow as any groundwater seepage to this spring is from the subsoil clays.

Habitat degradation as a result of introducing/spreading non-native invasive plant species

Introducing/spreading non-native invasive plant species could locally affect the extent, diversity, and vegetation composition or structure of habitats within Lough Corrib cSAC.

Mortality risk from construction works and road traffic

Constructing a bridge over the River Corrib poses a mortality risk to aquatic species beneath in the river; albeit a low level risk of having any long-term population level effects, given the temporary nature of the proposed works.

Operation of the proposed road development present a permanent risk of Otter mortality along the River Corrib corridor, and in the vicinity of the Coolagh Lakes, due to road traffic collisions and could have long-term effects on the Otter population of Lough Corrib cSAC.

Refer also to Table 9.16 and Table 9.17 in the NIS for how these impacts relate to the QI habitats and species and the specific conservation objectives of each QI potentially affected by the proposed road development.

Lough Corrib SPA

As the proposed road development does not traverse the SPA, none of the SCI species, or their supporting habitats within the SPA, are directly impacted by the proposed road development.

However, there are the following impacts by which the proposed road development could (in the absence of mitigation measures) affect the SCI bird species of Lough Corrib SPA and their supporting wetland habitats:

- Habitat degradation as a result of hydrogeological impacts
- Habitat degradation as a result of hydrological impacts
- Disturbance/displacement

Habitat degradation as a result of hydrogeological impacts

The proposed road development could affect the groundwater quality at potential ex-situ sites used by wintering bird species listed as SCIs for Lough Corrib SPA. This impact could affect the type, quality and extent of suitable habitat available to SCI bird species at ex-situ sites which lie within the hydrogeological ZoI. This impact could affect the type, quality and extent of suitable habitat available to SCI bird species locally and therefore, the number and range of areas available to the SPAs SCI bird populations and could have effects on their long-term population trends.

The design of the proposed road development avoids any long-term impacts to the existing groundwater regime that would affect any of the potential ex-situ sites used by SCI listed wintering birds. However, mitigation measures are required in the event that any groundwater conduits are encountered during construction and to ensure that karst features do not affect the functioning of the infiltration basins during operation.

Habitat degradation as a result of hydrological impacts

The proposed road development could affect the quality of surface water in the receiving environment which supports freshwater and wetland habitats at potential ex-situ sites used by SCI birds species of Lough Corrib SPA (Ballindooley Lough in particular). This impact could affect the type, quality and extent of suitable habitat available to SCI bird species locally and therefore, the number and range of areas available to the SPAs SCI bird populations and could have effects on their long-term population trends.

Disturbance/displacement

Long-term blasting in the vicinity of Ballindooley Lough could displace SCI listed bird species from this site for one or more winter seasons. Displacing SCI bird species from Ballindooley Lough, an important local site for some of the wintering bird species listed as SCIs for Lough Corrib SPA, could potentially negatively affect the long-term population trends of wintering SPA population.

The following, are the bird species listed as SCIs for Lough Corrib SPA which were recorded within the ZoI of the proposed road development and are therefore, at risk of significant effects: Shoveler, Tufted duck, Hen harrier, Coot, Golden plover, Black-headed gull, Common gull and Common tern. Wetlands are also listed as an SCI and could also be affected by the proposed road development. None of the other SCIs are at risk of impacts from the proposed road development as they are not present within the ZoI of the proposed road development.

Refer also to Table 9.30 and Table 9.31 in the NIS for how these impacts relate to the SCI species and the specific conservation objectives of each SCI potentially affected by the proposed road development.

Galway Bay Complex cSAC

As the proposed road development does not traverse Galway Bay Complex cSAC, none of the QI habitats or species will be directly impacted by the proposed road development and there is no risk of direct habitat loss or habitat fragmentation or direct mortality risk to QI species within the European site. Galway Bay Complex cSAC is also beyond the ZoI of any air quality or hydrogeological effects from the proposed road development. There is also no risk of disturbance associated with either construction or operation of the proposed road development affecting Otter or Harbour seal populations within Galway Bay Complex cSAC.

However, there are the following impacts by which the proposed road development could (in the absence of mitigation measures) affect the QI habitats and species of Galway Bay Complex cSAC:

- Habitat degradation as a result of hydrological impacts
- Habitat degradation as a result of introducing/spreading non-native invasive plant species
- Barrier effect
- Mortality risk

Habitat degradation as a result of hydrological impacts

The proposed road development could affect surface water quality in the receiving environment which supports freshwater, wetland and marine habitats, within Galway Bay Complex cSAC. These habitats in turn support Otter and the Harbour seal. With respect to the QI habitats and species and their conservation objectives, this impact could affect:

- The structure, extent and distribution of intertidal and marine communities associated with QI habitats
- The number and extent of typical plant and animal species associated with QI habitats
- Habitat area and distribution along with the vegetation structure and composition
- Otter prey abundance and the availability of holt and couch sites
- The condition of Harbour seal breeding and haul out sites

Habitat degradation as a result of introducing/spreading non-native invasive plant species

Introducing/spreading non-native invasive plant species could affect the extent, distribution, extent and diversity of Calcareous grassland habitats around Rusheen Bay and also affect the structure and composition of the vegetation.

Barrier effect

Introducing new culverts on watercourses within the Bearna Stream catchment may present a barrier to Otter movement throughout that catchment, potentially affecting the Otter population of Galway bay Complex cSAC.

Mortality risk

Introducing new road crossings on watercourses within the Bearna Stream catchment increases the risk of road traffic collisions with Otter, potentially affecting long-term population trends of the Otter population of Galway bay Complex cSAC.

Refer also to Table 9.23 and Table 9.24 in the NIS for how these impacts relate to the QI habitats and species and the specific conservation objectives of each QI potentially affected by the proposed road development.

Inner Galway Bay SPA

As the proposed road development does not cross the SPA, none of the SCI species, or their supporting habitats within the SPA, are directly impacted by the proposed road development. At its nearest point, the proposed road development is more than 1km from the SPA boundary and therefore, there is no risk of disturbance/displacement of SCI birds from habitats within the SPA.

However, there are the following impacts by which the proposed road development could (in the absence of mitigation measures) potentially affect the SCI bird species of Inner Galway Bay SPA and their supporting wetland habitats:

- Habitat degradation as a result of hydrogeological impacts
- Habitat degradation as a result of hydrological impacts
- Disturbance/displacement

Habitat degradation as a result of hydrogeological impacts

The proposed road development could affect the groundwater quality at potential ex-situ sites used by wintering bird species listed as SCIs for Inner Galway Bay SPA. This impact could affect the type, quality and extent of suitable habitat available to SCI bird species at ex-situ sites which lie within the hydrogeological ZoI. This impact could affect the type, quality and extent of suitable habitat available to SCI bird species locally and therefore, the number and range of areas available to the SPAs SCI bird populations and could have effects on their long-term population trends.

The design of the proposed road development avoids any long-term impacts to the existing groundwater regime that would affect any of the potential ex-situ sites used by SCI listed wintering birds. However, mitigation measures are required in the event that any groundwater conduits are encountered during construction and to ensure that karst features do not affect the functioning of the infiltration basins during operation.

Habitat degradation as a result of hydrological impacts

The proposed road development could affect the quality of surface water in the receiving environment which supports freshwater, wetland and marine habitats, within Inner Galway Bay SPA and at potential ex-situ sites used by SCI birds species (Ballindooley Lough in particular). This impact could affect the type, quality and extent of suitable habitat available to SCI bird species locally and therefore, the number and range of areas available to the SPAs SCI bird populations and could have effects on their long-term population trends.

Disturbance/displacement

Long-term blasting in the vicinity of Ballindooley Lough could displace SCI listed bird species from this site for one or more winter seasons. Displacing SCI bird species from Ballindooley Lough, an important local site for some of the wintering bird species listed as SCIs for Inner Galway Bay SPA, could potentially negatively affect the long-term population trends of wintering SPA population.

As Galway Bay lies downstream of the proposed road development, and lies within its ZoI, all bird species listed as SCIs for Inner Galway Bay SPA are at risk from impacts associated with the proposed road development: Great northern diver, Cormorant, Grey heron, Light-bellied brent goose, Wigeon, Teal, Shoveler, Red-breasted merganser, Ringed plover, Golden plover, Lapwing, Dunlin, Bar-tailed godwit, Curlew, Redshank, Turnstone, Black-headed gull, Common gull and Common tern. Wetlands are also listed as an SCI and could also be affected by the proposed road development.

Refer also to Table 9.37 and Table 9.38 in the NIS for how these impacts relate to the SCI species and the specific conservation objectives of each SCI potentially affected by the proposed road development.

8.5.3.2 Natural Heritage Areas and proposed Natural Heritage Areas

Considering the ZoI of the proposed road development, in the absence of mitigation measures the proposed road development has the potential to have a likely significant effect upon the following three NHAs/pNHAs:

- Lough Corrib pNHA
- Moycullen Bogs NHA
- Galway Bay Complex pNHA

The locations of these designated areas for nature conservation relative to the proposed road development, and the predicted ZoI, are shown on **Figure 8.13.1**.

8.5.3.2.1 Moycullen Bogs NHA

The proposed road development lies immediately adjacent to Moycullen Bogs NHA at Tonabrocky. This portion of the NHA consists of a mosaic of Lowland blanket bog (PB3) which included the Annex I habitats Blanket bog [*7130] and *Rhynchosporion* depressions [7150], Wet heath (HH3) which corresponded with the Annex I habitat Wet heath [4010], Transition mire (PF3) which corresponded with the Annex I habitat Transition mires [7140], Dry heath (HH1) which corresponded with the Annex I habitat Dry heath [4030] and Scrub (WS1).

Habitat Degradation – Air Quality

Emissions from car exhausts, and the deposition of particulate matter and heavy metals produced by engine, brake and tyre wear, can contribute to increased deposition of pollutants such as oxides of nitrogen (NO_X, NO_s), volatile organic compounds (VOCs), particulate matter (PM), heavy metals (HM) and ammonia (NH_4) in the vicinity of a road carriageway. This can affect the ecosystems and vegetation present, influencing plant growth rates and species composition, diversity, and abundance.

The current understanding of air quality impacts from roads and their interaction/effects on ecology are set out in the TII guidance document *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* (National Roads Authority, 2011) and two UK reports: *The Ecological Effects of Diffuse Air Pollution from Road Transport* (Bignal et al., 2004) and *The Ecological Effects of Air Pollution from Road Transport: An Updated Review* (Natural England, 2016).

Although carbon monoxide (CO), carbon dioxide (CO_2) and sulphur dioxide (SO_2) are generated by vehicles they are not currently thought to be of importance in terms of contributing to air quality impacts to vegetation and are not discussed further (Bignal et al., 2004; Natural England, 2016).

Construction Impacts

Dust emissions associated with construction works could, in extreme circumstances, affect adjoining habitats, potentially burying sensitive habitats or plant species. Best practice construction methodologies (e.g. watering of the construction site/access roads and road cleaning) and mitigation measures (dust screens during construction – see **Section 8.6.3**) have been designed to minimise construction generated dust and to contain it within the proposed development boundary.

Operational Impacts

NOx, NOs and NH3

Air quality modelling of NO_x concentrations and deposition rates were calculated along the proposed road development at distances up to 200m from the proposed road development (refer to **Section 16.5.4** of **Chapter 16, Air Quality and Climate** for details). The Air Quality Standards Regulations (AQS) 2011 (S.I. No. 180 of 2011) have a limit value of 30µg/m^3 for the protection of vegetation.

In the majority of areas, the worst-case predicted annual average NO_x concentrations at various distances from the proposed road edge comply with the limit value of 30µg/m^3 for the Do-Something scenario, in 2024 and in 2039, including background concentrations. This includes the areas adjacent to the boundary of Moycullen Bogs NHA, where the road edge lies 40m from the NHA boundary. Predicted concentrations are in compliance with the Air Quality Standard for the protection of vegetation (limit value of 30µg/m^3). Therefore, even at 10m from the proposed road edge, harmful effects on vegetation from NO_x are not likely.

The contribution of the proposed road development to the NO_2 dry deposition rate along a 200m transect from the proposed road edge is well below the critical load for the lower boundary limit of inland and surface water habitats of 5-10 Kg(N)/ha/yr (National Road Authority, 2011) and therefore, harmful effects on vegetation within Moycullen Bogs NHA from NO_2 are not likely.

Ammonia (NH_3) is emitted in small amounts by vehicles but atmospheric concentrations are well below critical levels for this pollutant (Bignal et al., 2004 and Natural England, 2016) and therefore, effects on vegetation within Moycullen Bogs NHA from ammonia are not likely.

Volatile Organic Compounds (VOCs)

In terms of volatile organic compounds (VOCs), modelled benzene concentrations are well below the air quality standard of 5µg/m^3 for the protection of human health and the environment as a whole (refer to **Section 16.5.4** of **Chapter 16, Air Quality and Climate** for details). Comparisons of emission factors of VOCs (mg/vehicle/km) have been examined in order to estimate an appropriate ratio of ethylene to benzene. The highest ratio of ethylene to benzene determined was 3:1, for vehicles which were primarily diesel emissions. Increases in ethylene from the proposed road development have been predicted using this ratio and the predicted levels were low at 10m from the proposed road edge (refer to **Section 16.5.4** of **Chapter 16, Air Quality and Climate** for details). No background data is available for ethylene. There is little evidence of ecological damage by vehicle related VOCs and given the low concentrations predicted, no impacts on vegetation within Moycullen Bogs NHA are likely.

Partiulate Matter and Heavy Metals

Heavy metals from car emissions are associated with emissions of Particulate Matter, PM_{10} (particulate matter less than 10µm) and $PM_{2.5}$ (particulate matter less than 2.5µm). An assessment of emissions of PM_{10} and $PM_{2.5}$ was prepared in accordance with TII guidelines using the DMRB modelling spreadsheet. Predicted concentrations are compared to the air quality standard of 40µg/m3 and 25µg/m3 respectively for the protection of human health and the environment as a whole. The maximum predicted concentrations along the route of the proposed road development for the Do-Something scenario, including background concentrations, were well below these standards (refer to **Chapter 16, Air Quality and Climate** for details).

Particulate matter (PM) and heavy metals (HM) decay at an exponential rate with distance from a road and the highest concentrations are generally present within 20-30m. Given the 20-30m zone within which the majority of PM/HM would be deposited, that Moycullen Bogs NHA lies c.40m from the proposed road edge, the low concentrations predicted, and dispersion due to wind, impacts on vegetation within the NHA from PM or HM are not likely.

Conclusion

During operation, air quality impacts from the proposed road development on vegetation within Moycullen Bogs NHA are not likely to occur and will not result in a likely significant negative effect, at any geographic scale.

Habitat Degradation – Non-native Invasive Plant Species

Planting, dispersing, or allowing/causing the dispersal, spread or growth of certain non-native plant species is controlled under Article 49 of the European Communities (Birds and Natural Habitats) Regulations, 2011; and refers to plant or animal species listed on the Third Schedule of those regulations (see also **Section 8.3.6**).

As the proposed road development lies immediately adjacent to the boundary of Moycullen Bogs NHA, the accidental spread of such non-native invasive plant species as a result of construction works has the potential to have long-term impacts upon habitat areas within the NHA; potentially affecting plant species composition, diversity and abundance.

Introducing any of these non-native invasive plant species to Moycullen Bogs NHA has the potential to result in a likely significant negative effect, at a national geographic through affecting habitat area and quality within the NHA. Mitigation measures have been designed to avoid this impact (see **Section 8.6.6**).

Habitat Degradation – Hydrogeology

Moycullen Bogs NHA is beyond the hydrogeological ZoI of the proposed road development (**Figures 10.7.1** to **10.7.14**, **10.8.1** to **10.8.14**, **10.9.1** to **10.9.14** and **10.10.1** to **10.10.14**) both in terms of the potential for impacts on groundwater quantity and/or groundwater quality that support the habitats therein. Therefore, the proposed road development cannot impact on any habitats or species within Moycullen Bogs NHA as a consequence of any impacts on the existing hydrogeological regime and is not likely to have a significant effect on the NHA in that regard.

Habitat Degradation – Surface Water Quality

During construction, contaminated surface water runoff and/or an accidental spillage or pollution event has the potential to have a significant negative effect on habitats and species in the adjoining Moycullen Bogs NHA. The effects of frequent and/or prolonged pollution events in a peatland complex have the potential to be extensive and far-reaching and could potentially have significant long-term effects.

However, it is considered unlikely that a pollution event of such a magnitude would occur during construction, or be any more than temporary in nature. Nevertheless, a precautionary approach is being taken in assuming a level of risk of water quality impacts. Consequently, detailed mitigation measures have been designed to further minimise the risk of the proposed road development having any perceptible effect on habitat quality in Moycullen Bogs NHA during construction (see **Section 8.6.4**).

Habitat degradation as a consequence of construction effects on surface water quality has the potential to affect the peatland habitat complex, and the species it supports in Moycullen Bogs NHA and therefore, has the potential to result in a significant negative effect.

Overall, in the absence of mitigation the proposed road development has the potential to affect the integrity of, and therefore have a significant negative effect on, Moycullen Bogs NHA as a result of air quality, non-native invasive plant species and surface water quality impacts during construction, potentially at the national geographic scale at which this receptor is valued.

8.5.3.2.2 Lough Corrib pNHA and Galway Bay Complex pNHA

In the case of Galway Bay Complex pNHA, which is remote from the proposed development boundary, the potential impact pathways connecting the proposed road development to Galway Bay are as presented and assessed in the NIS for Galway Bay Complex cSAC and Inner Galway Bay SPA (and summarised in **Section 8.5.3.1** above). As the proposed road development has the potential to adversely affect the integrity of Galway Bay Complex cSAC and Inner Galway Bay SPA, and hence the receiving marine environment in Galway Bay, it also has the potential to have a significant negative effect on Galway Bay Complex pNHA.

In relation to Lough Corrib pNHA, the potential impact pathways connecting the proposed road development to the pNHA site are also as per those presented above in **Section 8.5.3.1** and in the NIS for Lough Corrib cSAC and Lough Corrib SPA. However, the zone within which the proposed road development directly interacts with Lough Corrib pNHA is much smaller than that associated with Lough Corrib cSAC, and only includes the main river channel and banks. As the proposed road development has the potential, in the absence of mitigation measures, to adversely affect the integrity of Lough Corrib cSAC and Lough Corrib SPA, it also has the potential to affect the integrity of, and therefore have a significant negative effect on, Lough Corrib pNHA.

The proposed road development also has the potential to affect biodiversity in a broader sense than just the QIs/SCIs of those European sites. Where biodiversity receptors in Lough Corrib pNHA or Galway Bay Complex pNHA do not form part of the QIs/SCIs in the NIS assessment, they are considered under the other individual impact assessment headings for each KER below.

8.5.4 Habitats

This section assesses the potential impact of the proposed road development on habitats. Its focus is on habitat impacts outside designated areas for nature conservation which are discussed separately in **Section 8.5.3**, and detailed in the NIS.

In terms of quantifying the magnitude of effects for both Annex I and non-Annex I habitats, the estimated percentage of the local habitat resource being affected is based upon the total area of a given habitat type that was recorded within the scheme study area, regardless of whether it was within a designated area for nature conservation or not. This provides some local context as to the magnitude of the habitat loss and whether the impact is significant or not, and at what geographic scale.

8.5.4.1 Construction Phase Impacts

Habitat Loss & Fragmentation

The construction of the proposed road development will result in habitat loss across its length, totalling approximately 280ha. Some of the habitat types directly affected are considered to be of International/National importance, given their priority Annex I/Annex I status under the Habitats Directive. In the western part of the study area the Annex I habitats affected are Dry heaths [4030], Wet heath [4010], *Molinia* meadows [6410] and Blanket bog (active) [*7130]. East of the River Corrib the Annex I habitat types affected are Limestone pavement [*8240], Calcareous grassland [6210], Residual alluvial forests [*91E0], Turloughs [*3180], Petrifying springs [*7220] and *Molinia* meadows [6410]. These cover an area of approximately 8.8ha.

Other habitat types considered to be of a Local Importance (higher value) will also be lost as a result of the proposed road development. These include hedgerows (WL1), treelines (WL2), sections of stream/river channel (FW1), grasslands (GS1, GS2, GS3 and GS4), woodlands (WD1 and WN2) and scrub (WS1). These cover an area of approximately 75.5ha[56].

The remaining areas of habitat within the proposed development boundary (c.196ha) are made up of habitats of a Local Importance (lower value). This is

[56] Although some of the local importance habitats types (both higher and lower value) will be directly affected within Lough Corrib cSAC (e.g. WD1, WN2 and BL3) none of these habitat types are QIs, or support QI habitats or species, and losses of these habitat types within Lough Corrib cSAC will not affect the site's conservation objectives

primarily made up c.76ha of Improved agricultural grassland (GA1), c.32ha of Buildings and artificial surfaces (BL3), c.18ha of Spoil and bare ground (ED2), c.17ha of Dry calcareous and neutral grassland (GS1), c.14ha of Dense bracken (HD1), c.10ha of residential properties and c.9ha of Amenity grassland (improved) (GA2). Flower beds and borders (BC4), Recolonising bare ground (ED3), Other artificial lakes and ponds (FL8), Dry meadows and grassy verges (GS2), Dry-humid acid grassland (GS3), Wet grassland (GS4) and Ornamental/non-native shrub (WS3) make up the remainder.

The various KER habitat types affected, and the areas involved, are summarised below in **Table 8.27**. These calculations include all KER habitat areas within the proposed development boundary, as the possibility of areas within the proposed development boundary but outside of the footprint of the proposed road development itself being affected by construction activities cannot be ruled out.

Habitat loss may also lead to habitat fragmentation in many instances; creating new divisions of existing habitat blocks or contributing to an existing trend of fragmenting semi-natural habitat blocks — as has been happening to some areas of upland habitat in the western part of the study area, as a result of other development.

In the assessment below, where reference areas are used to calculate the percentage habitat loss of areas of Local Importance (higher value) these include areas that correspond with Annex I habitat types (where applicable).

The mitigation measures that have been designed to avoid or reduce the effects of direct impacts to habitats are in **Section 8.6.2**.

Table 8.27: KER habitat types within the proposed development boundary

Habitat type	Extent[57]
International Importance	
Turlough [*3180]	One (c.0.04ha of c.0.1ha is within fenceline)
Petrifying springs [*7220]	One feature
Residual alluvial forests [*91E0]	c.0.1ha
Limestone pavement [*8240]	c.2.3ha[58]
National Importance	
Wet heath [4010]	c.1.22ha
Wet heath/Dry heaths mosaic [4010/4030]	c.0.7ha
Dry heaths [4030]	c.1.96ha
Wet heath/Dry heath/*Molinia* meadow [4010/4030/6410]	c.0.43ha
Calcareous grassland [6210]	c.1.14ha
Molinia meadow [6410]	c.1.02ha

[57] This includes either a measure of habitat area (ha), linear length of habitat lost (m/km), or a total number of point features affected (e.g. spring/seepage sites), as appropriate.
[58] Some of the Limestone pavement habitat within the proposed development boundary lies within Lough Corrib cSAC – some of which also included areas of Calcareous grassland [6210] in a mosaic.

Habitat type	**Extent[57]**
Limestone pavement/Calcareous grassland mosaic [*8240/6210]	c.0.12ha
Local Importance (higher value)	
Calcareous springs (FP1)	Fifteen features
Reed and large sedge swamps (FS1)	c.0.14ha
Tall-herb swamp (FS2)	c.0.03ha
Eroding/upland rivers (FW1)	c.120m of Sruthán na Líbeirtí c.220m of the Trusky Stream c.140m of the Bearna Stream (and tributary) c.475m of the Tonabrocky Stream see **Section 8.5.4.3** for more details
Drainage ditches (FW4)	c.0.12ha
Marsh (GM1)	c.0.2ha
Dry calcareous and neutral grassland (GS1)	c.13.7ha
Dry calcareous and neutral grassland/Scrub mosaic (GS1/WS1)	c.1.55ha
Dry meadows and grassy verges (GS2)	c.8.2ha
Dry-humid acid grassland (GS3)	c.7.81ha
Wet grassland (GS4)	c.11.14ha
Poor fen and flush (PF2)	c.0.13ha
(Mixed) broadleaved woodland (WD1)	c.4.25ha
Mixed broadleaved/conifer woodland (WD2)	c.0.03ha
(Mixed) conifer woodland (WD3)	c.0.01ha
Oak-ash-hazel woodland (WN2)	c.4.18ha
Scrub (WS1)	c.21.12ha
Scrub/ Dry meadows and grassy verges (WS1/GS2)	c.1.47ha
Scrub/Oak-ash-hazel woodland/ Exposed calcareous rock (WS1/WN2/ER2)	c.1.3ha
Hedgerows (WL1)	c.7.8km
Treelines (WL2)	c.4km

Habitat Degradation – Surface Water Quality

During construction, contaminated surface water runoff and/or an accidental spillage or pollution event into any surface water feature has the potential to have a significant negative impact on water quality and consequently affect aquatic and wetland habitats in the receiving environment. The effects of frequent and/or prolonged pollution events in a river system have the potential to be extensive and far-reaching and could potentially have significant long-term effects. In a worst-case scenario, estuarine and coastal habitats downstream could also be affected.

However, it is considered unlikely that a pollution event of such a magnitude would occur during construction, or be any more than temporary in nature. Nevertheless, a precautionary approach is being taken in assuming a level of risk of water quality impacts. Consequently, detailed mitigation measures are required to further minimise the risk of the proposed road development having any perceptible effect on water quality during construction.

Habitat degradation as a consequence of construction effects on surface water quality has the potential to affect the conservation status of aquatic, wetland or estuarine/marine habitats and therefore, has the potential to result in a significant negative impact.

The mitigation measures that have been designed to avoid or reduce the potential impacts of the proposed road development on surface water quality are presented in **Section 8.6.4**.

Habitat Degradation – Hydrological Regime

Construction works at the watercourse crossings along the proposed road alignment can have a temporary impact on the flow and flooding regime locally. None of these are predicted to have any long-term effects that would give rise to a likely significant negative effect on any aquatic habitats or species through effects on the hydrological regime (for more detail refer to **Section 11.5** of **Chapter 11, Hydrology**).

Habitat Degradation – Groundwater

Any effects on the existing hydrogeological baseline supporting lakes, turloughs, and wetland or peatland habitats has the potential to negatively impact upon habitat extent and distribution, and vegetation structure and composition. The potential effects of impacting upon the existing hydrogeological regime are not necessarily limited to habitats within the proposed development boundary but can be far-reaching, with significant negative long-term effects[59].

There will be no impacts to groundwater recharge rates during construction that will have any effect on biodiversity receptors. All groundwater intercepted by construction works will be managed and discharged within the same GWB and will remain within the surface water catchment that they would naturally have been received by. The groundwater recharge rate will not change in the Galway Granite Batholith aquifer (the area west of the N59 Moycullen Road) with only a temporary minor increase in the recharge rate (between 0.1m and 0.4m) in the Visean Undifferentiated Limestone aquifer (the area east of the N59 Moycullen Road). Although there will be some loss of aquifer volume in the Galway Granite Batholith aquifer and the Visean Undifferentiated Limestone aquifer, it will have an imperceptible impact on the groundwater resource (for more detail refer to **Section 10.5** of **Chapter 10, Hydrogeology**).

During construction, deep excavations or tunnelling are likely to interact with groundwater. As a consequence, construction works have the potential to affect groundwater levels from construction dewatering or drawdown associated with

[59] The potential hydrogeological ZoI of the proposed road development is shown on **Figures 10.7.1** to **10.7.14**, **10.8.1** to **10.8.14**, **10.9.1** to **10.9.14** and **10.10.1** to **10.10.14**.

excavations. There is also the potential that construction works could impact on groundwater flow paths or conduits, potentially affecting groundwater dependant or supported habitats and/or species. There is also a higher risk of impacts to groundwater quality through contaminated surface water runoff and/or an accidental spillage or pollution. As above in relation to surface water features, impacts on the groundwater could potentially have a significant negative effect on biodiversity.

Based on the findings of the hydrogeological impact assessment in **Chapter 10, Hydrogeology**, the proposed road development does not pose a risk to the groundwater supply to Ballindooley Lough. Nor does it pose a risk of affecting the turlough features at Menlough (c.320m north-west of Ch. 10+100), at Ballinfoyle c.190m south of Ch. 12+100, and at Ballindooley c.400m north of the N84 Headford Road Junction.

The proposed road development does however, have the potential to affect the groundwater supply to the Coolagh Lakes (which form part of the Lough Corrib cSAC) and the turlough located between Bóthar Nua and Seanbóthar (Ch. 10+320). Although the magnitude of the impact cannot be fully quantified, on a precautionary basis it is assessed as having the potential to affect water levels at these features and thereby, affect the supported aquatic and wetland habitats. The assessment of impacts relating to European sites are discussed separately in **Section 8.5.3.1**, and detailed in the NIS.

The proposed Menlough Viaduct will be constructed over the Turlough located between Bóthar Nua and Seanbóthar (Ch. 10+320). Although none of the supporting piers will be located within the Turlough, there is the potential for construction works to affect the supporting hydrogeological regime.

Habitat degradation as a consequence of construction effects on the existing groundwater resource and regime has the potential to affect the conservation status of groundwater dependant aquatic or wetland habitats and species and therefore, has the potential to result in a significant negative impact.

A more detailed description of how the proposed road development could affect the existing hydrogeological regime during construction is presented in **Chapter 10, Hydrogeology**.

The mitigation measures that have been designed to avoid or reduce the potential impacts of the proposed road development on groundwater are presented in **Section 8.6.5**.

Habitat Degradation – Air Quality

As discussed above in **Section 8.5.3.2**, the proposed road development has the potential to generate dust during construction works which could affect vegetation in habitat areas adjacent to the proposed development boundary. Mitigation measures have been designed to contain dust emissions during construction (see **Section 8.6.3**).

Habitat Degradation – Non-native Invasive Plant Species

Planting, dispersing, or allowing/causing the dispersal, spread or growth of certain non-native plant species is controlled under Article 49 of the European Communities (Birds and Natural Habitats) Regulations, 2011; and refers to plant or animal species listed on the Third Schedule of those regulations (see also **Section 8.3.6**).

The accidental spread of such non-native invasive plant species as a result of construction works has the potential to impact upon terrestrial habitats[60]; potentially affecting plant species composition, diversity and abundance over the long-term. This is not only confined to habitats within and immediately adjacent to the proposed development boundary but includes habitat areas along the network of proposed haul routes associated with the proposed road development (**Figure 7.101** to **7.118**).

The effects of introducing such non-native invasive plant species to highly sensitive and ecologically important habitat areas (e.g. designated area for nature conservation or areas of Annex I habitat) have the potential to result in a likely significant negative effect, at geographic scales ranging from local to international. Mitigation measures have been designed to avoid this potential impact (see **Section 8.6.6**).

Habitat Degradation – Tunnelling/Excavation

Tunnelling works or deep excavations have the potential to affect the structural integrity of the ground above a tunnel excavation, or that of the ground immediately adjacent to a deep cutting/excavation. This in turn can affect the habitats present.

This potential impact is only likely to arise in to the habitats present within Lough Corrib cSAC and either above the proposed Lackagh Tunnel or immediately adjacent to the cutting associated with the western approach to same. At this location, the overlying/adjoining habitats within Lough Corrib cSAC comprise a mosaic of wooded Limestone pavement [*8240], scrub covered Limestone pavement [*8240], exposed Limestone pavement [*8240], and Calcareous grassland [6210]. All of these habitat types are QI habitats of Lough Corrib cSAC. This assessment is discussed separately in **Section 8.5.3.1**, and detailed also in the NIS.

8.5.4.2 Operational Phase Impacts

Habitat Degradation – Surface Water Quality

During operation, there will be drainage outfalls to all river/stream catchments crossed by the proposed road development. Therefore, there is a risk that discharges from the road drainage network could affect water quality, potentially over the long-term, and consequently impact upon aquatic/wetland habitats. In a worst-case-scenario, this could result in long-term effects upon habitat extent and distribution, vegetation structure and composition.

[60] Non-native invasive aquatic plant species (or fauna species) were not recorded in the aquatic habitats which will be impacted by construction works.

The proposed drainage design consists of a petrol interceptor followed by attenuation and constructed wetland (where drainage will be discharged to the existing surface water/drainage network)—as described in detail in **Section 5.5.4.8** of **Chapter 5**, **Description of Proposed Road Development**. The drainage design, along with the design of any culverts associated with the proposed road development and any stream/river realignments, also ensures that during operation there will not be any perceptible impacts on the functioning of the existing hydrological regime (e.g. flood risk, flow rates or river morphology).

Habitat degradation as a consequence of operational effects on surface water is not predicted to affect the conservation status of any aquatic, wetland or estuarine/marine habitats and will therefore, not result in a likely significant effect, at any geographic scale.

Habitat Degradation – Groundwater

There will be no impacts to groundwater recharge rates during construction that will have any effect on biodiversity receptors as all groundwater intercepted by the road drainage will be discharged to the same GWB. The infiltration basins will lead to local increases in the groundwater table but overall there will be no net change to the groundwater resource.

There will be no active dewatering, of the bedrock aquifer, required during the operation phase but passive dewatering, of the bedrock aquifer, will occur at a number of cutting locations and the drainage associated with the proposed road development will cause the groundwater levels to adjust locally. This impact on the hydrogeological regime has the potential to affect the conservation status of groundwater dependant aquatic or wetland habitats and species and therefore, has the potential to result in a significant negative impact.

Impacts to groundwater quality could be caused by discharging contaminated road runoff to ground or where leachate/runoff from limestone fill could affect the pH of acidic groundwater along the western section of the proposed road development.

The proposed drainage design consists of a petrol interceptor followed by attenuation and infiltration ponds (where discharging to ground) — as described in detail in **Section 5.5.4.8** of **Chapter 5, Description of Proposed Road Development**. The functioning and effectiveness of the proposed road drainage network are discussed in more detail in **Chapter 11, Hydrology**. The drainage design, including the design of the infiltration basins, minimises the risk of a pollution event during operation affecting groundwater quality. Risk of spillage is low (<0.5%) and any impacts that do accidentally occur will be temporary. However, it is important that they are inspected to ensure that karst features do not affect the functioning of the infiltration basins during operation. If this is identified during routine inspections of the infiltration basins then mitigation is required to ensure any issues are addressed so that they continue to function as designed over the design life of the proposed road development

Local impacts to the local water chemistry, in terms of pH change, may apply where limestone derived alkaline material is placed over granite bedrock. Surface water run-off, interflow or groundwater movements through such material has the potential to impact local areas of peatland habitats by changing the pH of the recharge water particularly where this alkaline material is saturated (below the groundwater table). This potential impact will only apply to adjacent peatland habitats within hydrogeological Zone of influence of the proposed road development. The use of limestone based road material for the pavement and capping layers does not pose such a risk as these layers will be protected from direct surface water and groundwater infiltration and are located in the unsaturated zone above the groundwater table. This protection is provided by the road bitumen surface and the use of native topsoil capping along the grass verge and embankment sections of the proposed road development. Restriction on the use of limestone derived formation material will apply locally to road sections in the vicinity of peatland habitats within the granite bedrock area (west of the existing N59 Moycullen Road).

A more detailed description of how the proposed road development could affect the existing hydrogeological regime during construction is presented in **Chapter 10, Hydrogeology**.

The mitigation measures that have been designed to avoid or reduce the potential impacts of the proposed road development on groundwater are presented in **Section 8.6.5**.

Habitat Degradation – Shading

There are two elevated structures associated with the proposed road development which will have some level of shading effect on the habitats beneath during operation: the proposed River Corrib Bridge (Ch. 8+850 to Ch. 9+500) and the proposed Menlough Viaduct (Ch. 10+100 to Ch. 10+420). The retaining wall along the southern edge of the proposed road carriageway between Ch. 9+840 and Ch. 10+025 also has the potential to cause a shading effect on adjacent habitats. Shading effects include both a reduction in sunlight and a reduction in direct precipitation reaching plants beneath the bridge structure, affecting species communities, diversity and distribution. This potential impact will only arise in situations where habitats are being retained beneath the structure, as opposed to where habitats will be permanently lost as a result of construction works.

Habitat Degradation – Non-native Invasive Plant Species

Given the presence of non-native invasive plant species listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations, 2011 in the immediate vicinity of the proposed road development, there is the potential that these species will recolonize vegetated areas within the proposed development boundary post-construction. As such, there is a risk that routine maintenance works may inadvertently spread contaminated vegetation cuttings.

The effects of introducing such non-native invasive plant species to highly sensitive and ecologically important habitat areas (e.g. designated areas for nature conservation or areas of Annex I habitat) have the potential to result in a significant negative effect, at geographic scales ranging from local to international. Mitigation measures have been designed to avoid this potential impact (see **Section 8.6.6**).

Habitat Degradation – Air Quality

NO_x, NO_s and NH_3

Air quality modelling of NO_x concentrations and deposition rates were calculated along the route of the proposed road development at distances up to 200m from the proposed road development (refer to **Chapter 16, Air Quality and Climate** for details). The Air Quality Standards Regulations (AQS) 2011 (S.I. No. 180 of 2011) have a limit value of 30µg/m^3 for the protection of vegetation.

In the majority of areas, the worst-case predicted annual average NO_x concentrations at various distances from the proposed road edge comply with the limit value of 30 µg/m^3 for the Do-Something scenario, in 2024 and in 2039, including background concentrations. All predicted concentrations are in compliance with the Air Quality Standard for the protection of vegetation (limit value of 30µg/m^3). Therefore, even at 10m from the proposed road edge in these locations, harmful effects on vegetation from NO_x are not likely.

The exception is the zone between the N84 Headford Road and the N83 Tuam Road where, due to the higher predicted traffic numbers, the limit value of 30µg/m^3 is exceeded marginally within 10m of the proposed road edge (predicted NO_x concentrations of 30.53µg/m^3). This reduces to below the limit value by 20m. In this area, there are no sensitive ecological receptors (e.g. Annex I habitats) within 20m of the proposed road edge and harmful effects on vegetation in ecologically sensitive areas nearby are not likely.

The contribution of the proposed road development to the NO_2 dry deposition rate along the 200m transect from the proposed road edge is well below the critical load for the lower boundary limit of inland and surface water habitats of 5-10 Kg(N)/ha/yr (National Road Authority, 2011) and therefore, harmful effects on vegetation from NO_2 are not likely.

Ammonia (NH_3) is emitted in small amounts by vehicles but atmospheric concentrations are well below critical levels for this pollutant (Bignal et al., 2004 and Natural England, 2016) and therefore, effects on vegetation are not likely.

Volative Organic Compounds

In terms of volatile organic compounds (VOCs), modelled benzene concentrations are well below the air quality standard of 5µg/m^3 for the protection of human health and the environment as a whole (refer to **Section 16.5.4** of **Chapter 16, Air Quality and Climate** for details). Comparisons of emission factors of VOCs (mg/vehicle/km) have been examined in order to estimate an appropriate ratio of ethylene to benzene. The highest ratio of ethylene to benzene determined was 3:1, for vehicles which were primarily diesel emissions. Increases in ethylene from the proposed road development have been predicted using this ratio and the predicted levels were low at 10m from the proposed road edge (refer to **Section 16.5.4** of **Chapter 16, Air Quality and Climate** for details). No background data is available for ethylene. There is little evidence of ecological damage by vehicle related VOCs and given the low concentrations predicted, no significant impacts on vegetation along the proposed road development are likely.

Particulate Matter and Heavy Metals

Heavy metals from car emissions are associated with emissions of Particulate Matter, PM_{10} (particulate matter less than 10µm) and $PM_{2.5}$ (particulate matter less than 2.5µm). An assessment of emissions of PM_{10} and $PM_{2.5}$ was prepared in accordance with TII guidelines using the DMRB modelling spreadsheet. Predicted concentrations are compared to the air quality standard of 40µg/m^3 and 25µg/m^3 respectively for the protection of human health and the environment as a whole. The maximum predicted concentrations along the proposed road development for the Do-Something scenario, including background concentrations, were well below these standards (refer to **Section 16.5.4** of **Chapter 16, Air Quality and Climate** for details).

Particulate matter (PM) and heavy metals (HM) decay at an exponential rate with distance from a road and the highest concentrations are generally present within 20-30m. Given the 20-30m zone within which the majority of PM/HM would be deposited, the low concentrations predicted, and dispersion due to wind, significant impacts on vegetation from PM or HM along the proposed road development are not likely.

8.5.4.3 Impact Assessment on Habitats

Turloughs [*3180]

Turloughs (FL6) which corresponds with this Annex I habitat type

The structure proposed for the Menlough Viaduct passes over the Turlough at Ch. 10+320 and avoids any direct impacts. This retention of the Turlough habitat in this area is captured in the mitigation strategy (**Section 8.6**) and shown on **Figure 8.23.7**. Construction and the long-term presence of the piers, whilst not located within the Turlough, they are situated immediately adjacent to it, pose a risk to the supporting hydrogeological regime and may affect both the functioning of the Turlough and the vegetation community present. Construction works also pose a pollution risk to groundwater and surface water quality.

The presence of groundwater conduits connecting the infiltration ponds at Ch. 10+650 to Ch. 10+800 to the Turlough, and also in relation to the infiltration ponds at Ballindooley Lough (Ch. 12+200) is unknown. If groundwater conduits do connect road drainage to the turlough there is the potential for impacts which could affect the vegetation composition and diversity.

Accidentally introducing non-native invasive plant species into turlough habitat could also increase the extent and magnitude of road effects, degrading the habitat quality; as could dust deposition during construction. Air quality effects on turlough habitat during operation are not likely to affect plant species composition, diversity or abundance.

There is therefore a risk that the proposed road development could result in the loss of turlough habitat, or have long-term effects on plant species composition. Such an impact would constitute a negative effect on conservation status[61] and result in a likely significant negative effect, at the international geographic scale.

Petrifying springs [*7220]

Calcareous springs (FP1) which corresponds with this Annex I habitat type

Six Calcareous springs corresponding with the Annex I habitat Petrifying springs [*7220] were recorded in Lackagh Quarry (see **Figure 8.15.8**).

One of these Petrifying springs (at the location of the proposed access road c.30m south of the mainline at Ch. 11+380) will be directly affected by the proposed road development and will be permanently lost.

The next Petrifying spring feature to the north, which lies c.25m to the north of the mainline at Ch. 11+400, lies within the area where rock stabilisation measures are required as part of the construction of the eastern entrance to the Lackagh Tunnel (see **Chapter 9, Soils and Geology**). Although no impacts are predicted as a result of any effects on the existing hydrogeological regime during construction or operation (refer to **Chapter 10, Hydrogeology**), the installation of rock stabilisation measures here could potentially directly impact on this Petrifying spring and result in the permanent loss of this feature.

None of the other four Petrifying spring features will be directly impacted by the proposed road development or affected in any way through impacts to the existing hydrogeological regime, during either construction or operation.

Loss of Petrifying spring features, as priority Annex I habitats, has the potential to result in a significant negative effect at the national or international geographic scales but only where habitat impacts would affect the habitat's conservation status at those levels. In order for habitat area loss to affect a habitat's favourable conservation status at a national level, it must affect the national favourable reference area (FRA), as this is the reference value against which the area parameter is measured in the context of assessing conservation status.

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[61] The methodology for determining effects on the conservation status on Annex I habitats at a national level is assessed under the headings of range, area, structure & function, and future prospects (NPWS 2013a, 2013b, 2013c). Under the area criterion, any loss of habitat area with respect to the Favourable Reference Range (FRA) results in the habitat moving from Favourable conservation status (if that is the baseline condition) to either Inadequate or Bad. If the baseline condition is either Inadequate or Bad, then additional habitat loss is adding to an existing decline and potentially inhibiting efforts to maintain or restore Annex I habitats at favourable conservation status at a national level. The FRA for any of the Annex I habitat types affected by the proposed road development are either estimates based on partial data, or values much greater than the current area based upon a statistically robust estimate—generally to account for historic losses or impacts Since the Habitats Directive came into force in 1994. The FRA are also not spatially defined. In applying the precautionary principle, due to the absence of a clearly defined FRA, the loss of any area of Annex I habitat is considered to be affecting conservation status at the geographic scale at which the particular Annex I habitat has been valued.
The same assessment methodology also applies when assessing conservation condition at a site level.

The FRA for this habitat type is defined as 0.139km^2 in NPWS (2013b) and it notes therein that "There is no evidence of decline in extent since the Directive came into force and therefore the current area is set as the Favourable Reference Area". The current FRA is based upon the data presented in NPWS (2013b) and as the 10km grid square within which the Petrifying springs affected by the proposed road development are located (M32) is not within the current Favourable Reference Range (FRR) of this habitat type, they cannot form part of the national FRA. Therefore, their loss cannot affect the conservation status of this habitat type at either the national or international geographic scales.

There is little data available as to the current number of Petrifying spring sites at the county level. However, considering the restricted range of this habitat type in County Galway (based upon the data presented in NPWS, 2013b) it is likely that the number of sites is restricted and the loss of even a single Petrifying spring is likely to be a significant negative effect, at the county geographic scale.

Residual alluvial forests [*91E0]

Wet willow-alder-ash woodland (WN6) which corresponds with this Annex I habitat type

The proposed road development will result in the permanent loss of approximately 0.1ha of Residual alluvial forest habitat. This equates to approximately 0.73% of this Annex I habitat type mapped within the scheme study area. Although, given the expanse of unsurveyed wet woodland habitat present along the River Corrib and on the shores of Lough Corrib to the north of the scheme study area, this percentage figure is likely to be an overestimate of the loss of Residual alluvial forest habitat locally.

Habitat degradation as a result of effects on the existing hydrogeological regime during construction and operation have the potential to affect areas of Residual alluvial forest that form an element of the wetland habitats supported by the Coolagh Lakes.

Accidentally introducing non-native invasive plant species could also increase the extent and magnitude of potential impacts due to the proposed road development; as could an accidental pollution event affecting the River Corrib, the Coolagh Lakes or Ballindooley Lough. There are no areas of this habitat type within the ZoI of air quality impacts with the potential to affect plant species composition, diversity or abundance.

Despite the relatively small area of habitat loss, the loss of any area of this priority Annex I habitat constitutes a negative effect on conservation status. Therefore, the loss of Residual alluvial forest habitat associated with the proposed road development will result in a likely significant negative effect, at the international geographic scale.

Wet heath [4010] & Dry heaths [4030]

Dry siliceous heath (HH1) and Wet heath (HH3) which corresponds with this Annex I habitat type

Wet heath and Dry heaths are assessed together, as both habitat types generally form intricate mosaics with one another in areas affected by the proposed road development. From Bearna to Ballagh (Ch. 0+000 to Ch. 8+300) a total of c.5.15ha of heathland habitats will be permanently lost as a direct result of construction works or through indirect hydrogeological effects: approximately 1.96ha of Dry heaths, 2.06ha of Wet heath[62], 0.7ha of Dry heaths/Wet heaths mosaic, c.0.43ha of Wet heath/*Molinia* meadow/Dry heath mosaic between Ch. 2+920 and Ch. 3+040 (in the ratio of 82/15/3%, respectively) and c.0.01ha of Dry heath/Scrub mosaic along the access road at Na Foraí Maola Thiar.

In the context of the total area of these Annex I habitat types recorded within the scheme study area, the areas lost represent approximately 1.8%. However even the areas of heath habitat recorded within the scheme study area are only likely to represent a proportion of the actual local heathland habitat resource[63]. Therefore, the actual percentage of habitat loss is likely to be much smaller.

The proposed road development will also increase the fragmentation of heathland habitats; although the affected habitat blocks are already isolated from the larger more cohesive areas to the north at Na Foraí Maola, Lough Inch, Cappagh, Tonabrocky and Ballagh which will be unaffected.

Habitat degradation as a result of effects on the existing hydrogeological regime during construction and operation is also likely to affect the areas of Wet heath along the proposed road development. The construction hydrogeological ZoI will be temporary and is not predicted to have long-term effects on its own. However, the operational hydrogeological ZoI (in the context of groundwater drawdown effects) extends beyond the proposed development boundary to include additional areas of heathland habitat. This is not likely to have any long-term effects on areas of Dry heath, but Wet heath habitats is likely to dry out to some degree, with decreasing effect from the road edge. As it is not possible to quantify the effects of the predicted groundwater drawdown of Wet heath habitat condition, a precautionary approach is being taken in assuming any Wet heath habitat within the operational hydrogeological ZoI will be permanently lost. For the purposes of the impact assessment, it is also assumed that in a mosaic of Dry heath and Wet heath that all habitat affected in this way is Wet heath (a worst-case approach as Dry heath is not likely to be affected by the effects of operational groundwater drawdown). The area of potential Wet heath habitat within this zone is c.0.84ha. The likelihood is that the species composition will change to resemble more of a Dry heath habitat type. Peatland habitats within the hydrogeological ZoI could be affected by

[62] This c.2.06ha of Wet heath habitat includes an area of c.1.23ha that lies within the proposed development boundary and will be directly impacted, and an additional c.0.84ha that lies outside of the proposed development boundary but within the hydrogeological ZoI.
[63] Based upon a review of available orthophotography for the km grid square M22 (which covers the western part of the scheme study area), approximately 40km^2 of upland habitats are likely to be present but are not described or mapped. These are likely to be a mosaic of heath and bog habitats.

groundwater pH change and mitigation measures will be implemented to avoid this impact.

Accidentally introducing non-native invasive plant species into heath areas could also increase the extent and magnitude of road effects on these habitat types, degrading the habitat quality; as could an accidental pollution event or dust deposition during construction. Air quality effects on heathland habitats during operation are not likely to affect plant species composition, diversity or abundance.

Despite the relatively small area of habitat loss, and that the areas that will be lost are a multitude of small, isolated habitat patches, considering the likely effects and ongoing pressures on these habitat types locally, the loss of any area of these Annex I habitats constitutes a negative effect on conservation status. Therefore, the loss of Wet heath and Dry heath habitat associated with the proposed road development will result in a likely significant negative effect, at the national geographic scale.

Calcareous grassland [6210]

Dry calcareous and neutral grassland (GS1) which corresponds with this Annex I habitat type

The proposed road development will result in the permanent loss of approximately 1.14ha of Calcareous grassland habitat: c.0.09ha at Lackagh Quarry (Ch. 11+750), three small patches between Ch. 12+000 and Ch. 12+220 (totalling c.0.13ha), and c.0.92ha at Doughiska (between Ch. 16+220 and Ch. 16+320). In the context of the total area of Calcareous grassland habitat recorded within the scheme study area, the areas lost represent approximately 2.23%. The Calcareous grassland habitat affected is the non-priority variant [6210] and as such, is valued as being of national importance.

There is also some Calcareous grassland habitat present in a mosaic with Limestone pavement within the boundary of Lough Corrib cSAC and, as assessed in the NIS, it is not directly impacted by the proposed road development (this is captured in the mitigation strategy and shown on **Figure 8.23.8** as habitat areas to be retained).

All of the affected areas are small, isolated grassland patches and therefore, the proposed road development will not have any significant fragmentation impacts on Calcareous grassland habitat locally.

Accidentally introducing non-native invasive plant species into Calcareous grassland habitat could also increase the extent and magnitude of road effects, degrading the habitat quality; as could an accidental pollution event or dust deposition during construction. During operation, air quality effects on Calcareous grassland habitat in the vicinity of the proposed road development are not likely to affect plant species composition, diversity or abundance.

Despite the relatively small area of habitat loss, and that the areas that will be lost are a multitude of small, isolated habitat patches, considering the likely effects and ongoing pressures on Calcareous grassland habitat locally, the loss of any area of this Annex I habitat constitutes a negative effect on conservation status. Therefore, the loss of the non-priority Calcareous grassland habitat associated with the proposed road development will result in a likely significant negative effect, at the national geographic scale.

Molinia meadow [6410]

Wet grassland (GS4) which corresponds with this Annex I habitat type

The proposed road development will result in the permanent loss of approximately 0.94ha of *Molinia* meadow habitat: an area of c.0.08ha at Na Foraí Maola (Ch. 0+900) and c.0.93ha at the southern end on the Ballindooley Lough wetland complex (Ch. 12+250 to Ch. 12+400).

In the context of the total area of *Molinia* meadow habitat recorded within the scheme study area, the areas lost represent approximately 4%. Although as noted above for the heath habitats, given the local expanse of unsurveyed upland habitat present to the north of the scheme study area this percentage figure is likely to be an overestimate of the loss of *Molinia* meadow habitat locally.

The *Molinia* meadow at Na Foraí Maola is an isolated patch with no existing connectivity to other semi-natural habitat sites across the proposed road development, largely due to the existing local road network and residential development. Therefore, habitat fragmentation effects are not likely to arise. The *Molinia* meadow affected at Ballindooley is at the very southern end of the wetland complex which itself is an isolated wetland ecosystem. Therefore, habitat fragmentation is not likely to effect the habitat or the wetland complex overall.

Accidentally introducing non-native invasive plant species into *Molinia* meadow habitat could also increase the extent and magnitude of road effects, degrading the habitat quality; as could an accidental pollution event or dust deposition during construction. During operation, air quality effects on *Molinia* meadow habitat in the vicinity of the proposed road development are not likely to affect plant species composition, diversity or abundance.

Despite the relatively small areas of habitat loss, considering the likely effects and ongoing pressures on *Molinia* meadow habitat locally the loss of any area of this Annex I habitat constitutes a negative effect on conservation status. Therefore, the loss of *Molinia* meadow habitat associated with the proposed road development will result in a likely significant negative effect at the national geographic scale.

Limestone pavement [*8240]

Exposed calcareous rock (ER2), Oak-ash-hazel woodland (WN2) and Scrub (WS1) which corresponds with this Annex I habitat type

There is c.2.3ha of Limestone pavement habitat present within the proposed development boundary. This figure includes c.0.12ha of Limestone pavement/Calcareous grassland mosaic above the Lackagh Tunnel. Of this c2.3ha, c.1.85ha lies outside of the boundary of Lough Corrib cSAC. The remainder lies within the boundary of Lough Corrib cSAC and, as assessed in the NIS, is not directly or indirectly impacted by the proposed road development (this is captured in the mitigation strategy and shown on **Figures 8.23.7** to **8.23.8** as habitat areas to be retained).

Therefore, the proposed road development has the potential to affect approximately 1.85ha of Limestone pavement habitat which lies within the proposed development boundary, and outside of Lough Corrib cSAC. In the context of the total area of

Limestone pavement habitat recorded within the scheme study area (c.180ha), the areas lost represent approximately 1%. Other areas of Limestone pavement habitat, outside of the area covered by the habitat surveys, have been mapped locally to the north of Menlough Village near Coolanillaun and Angliham Quarry (Natura, 2005) which cover an area of c.22ha. Adding this marginally reduces the percentage loss to c.0.9%.

The design of the proposed road development includes for a culvert structure to span over c.0.04ha of exposed Limestone pavement (LPE) at Ch. 10+030. This will ensure that this area of Limestone pavement is not permanently removed, the natural clint and grike structure of the pavement area is retained, and does not affect its area, or range at any geographic scale. However, some level of vegetation removal is likely to be required to facilitate construction of the culvert, and the resulting shading effects of the structure (c.4.5m high and c.30m wide, over approximately 68% of this habitat patch) will likely affect the extent and species composition of the vegetation cover beneath the structure, reducing the quality of the Limestone pavement habitat remaining. However, in the context of the overall area of Limestone pavement habitat present locally (c.202ha, of which the area partially beneath the culvert represents <0.02%), affecting the quality of such a small area is preferable than loss of the area entirely and reduces the magnitude of the impact the proposed road development will have on this habitat type.

The Menlough Viaduct passes over c.0.7ha of Limestone pavement habitat between Ch. 10+100 and Ch. 10+425; the construction of which is likely to affect the habitats beneath through vegetation removal during site clearance, habitat loss, and shading from the viaduct structure during operation. The affected habitat areas include c.0.05ha of wooded Limestone pavement (LPW) west of Bóthar Nua (Ch. 10+100) and, between Bóthar Nua and Seanbóthar (Ch. 10+130 to Ch. 10+475), c.0.07ha of LPE and c.0.67ha of LPW. The construction methodology described in the constructability report in **Appendix A.7.2**, will ensure that construction impacts will only be temporary for the majority of this area due to the limestone pavement protection system that will be used. Use of this protection system will result in any vegetation beneath it being supressed for the duration of construction. Although some level of vegetation is likely to recolonise when the temporary protection system is removed, this will be inhibited by the shading effects of the viaduct structure and the existing species composition is not likely to fully re-establish itself. The area of Limestone pavement that will be permanently lost to the supporting piers is c.0.05ha. Although the viaduct will reduce the quality of Limestone pavement habitat remaining, as above, the area affected is relatively small in the context of the local habitat resource (c.0.03%) and retaining, rather than the permanent loss of, Limestone pavement habitat reduces the magnitude of the impact the proposed road development will have on this habitat type.

The other Limestone pavement areas within the proposed development boundary, but outside of Lough Corrib cSAC, is a total area of c.1.1ha. Construction works are likely to result in either the loss of, or significant damage to, these Limestone pavement habitat areas.

There is also c.0.44ha of Limestone pavement and Calcareous grassland within Lough Corrib cSAC which lie above the proposed Lackagh Tunnel. Although this habitat area will not be directly affected by the proposed road development, tunnelling beneath it poses a risk to the structural integrity of the rock mass that supports surface above and therefore, could affect these Annex I habitats. This is assessed further in the NIS.

In terms of habitat fragmentation, the only area of Limestone pavement outside of Lough Corrib cSAC that will be bisected by the proposed road development is that beneath the Menlough Viaduct. As this structure will be elevated on piers across its length (between Ch. 10+100 to Ch. 10+425), and substantial areas of this habitat type remain on either side, the proposed road development will not have any significant fragmentation impacts on Limestone pavement habitat locally.

Accidentally introducing non-native invasive plant species into Limestone pavement habitat areas could also increase the extent and magnitude of road effects on these habitat types, degrading the habitat quality; as could an accidental pollution event or dust deposition during construction. Air quality effects on exposed or wooded Limestone pavement habitats during operation are not likely to affect plant species composition, diversity or abundance.

Despite the relatively small area of habitat affected by the proposed road development in the context of the local resource, considering the likely effects and ongoing pressures on Limestone pavement habitat, the loss of any area of this Annex I habitat constitutes a negative effect on conservation status. Therefore, the loss of Limestone pavement habitat associated with the proposed road development will result in a likely significant negative effect at the international geographic scale.

Hard water lakes [3140]

Limestone/marl lakes (FL3) which corresponds with this Annex I habitat type

The complex of Hard water lakes at the Coolagh Lakes are within Lough Corrib cSAC and are assessed in the NIS. There are no direct impacts on this habitat type in Lough Corrib cSAC. The proposed road development has the potential to affect both the groundwater and surface water regimes supporting the Hard water lake habitat in Lough Corrib cSAC.

Although there are no direct impacts on Ballindooley Lough, run-off from the proposed road development during construction has the potential to affect surface water quality. Ballindooley Lough is upgradient from the proposed road development, in terms of groundwater flow, and there is therefore no potential for groundwater impacts to the lake itself.

As an Annex I habitat type, negatively affecting the water quality status of Ballindooley Lough has the potential to degrade the Hard water lake habitat and result in a likely significant residual effect, at the national geographic scale.

Alkaline fen [7230]

Rich fen and flush (PF1) which corresponds with this Annex I habitat type

The Alkaline fen along the River Corrib and associated with the Coolagh Lakes are within Lough Corrib cSAC and, as assessed in the NIS, there are no direct impacts on this habitat type in Lough Corrib cSAC. The proposed road development has the potential to affect both the existing groundwater regime and surface water quality (during construction in the absence of mitigation measures) supporting wetland habitats in Lough Corrib cSAC.

Although there are no direct impacts on Ballindooley Lough, run-off from the proposed road development during construction has the potential to affect surface water quality and the Alkaline fen habitat associated with the wetland complex there. Ballindooley Lough is upgradient from the proposed road development, in terms of groundwater flow, and there is therefore no potential for groundwater impacts to those areas of the wetland complex that support Alkaline fen habitat.

As an Annex I habitat type, negatively affecting surface water quality at the Ballindooley Lough wetland complex has the potential to degrade the Alkaline fen habitat and potentially result in a likely significant residual effect at the national geographic scale.

Hydrophilous tall herb [6430]

Reed and large sedge swamps (FS1), Tall-herb swamps (FS2) and Marsh (GM1) which corresponds with this Annex I habitat type

The Hydrophilous tall herb habitat along the River Corrib and associated with the Coolagh Lakes are within Lough Corrib cSAC and are assessed in the NIS. There are no direct impacts on this habitat type in Lough Corrib cSAC. The proposed road development has the potential to affect both groundwater and surface water quality supporting wetland habitats, including Hydrophilous tall herb habitat, in Lough Corrib cSAC.

Cladium fen [*7210]

Reed and large sedge swamps (FS1), Tall-herb swamps (FS2) and Rich fen and flush (PF1) which corresponds with this Annex I habitat type

The *Cladium* fen along the River Corrib and associated with the Coolagh Lakes are within Lough Corrib cSAC and are assessed in the NIS. There are no direct impacts on this habitat type in Lough Corrib cSAC. The proposed road development has the potential to affect both groundwater and surface water quality supporting wetland habitats in Lough Corrib cSAC.

Although there are no direct impacts on this habitat type at Ballindooley Lough, run-off from the proposed road development during construction has the potential to affect surface water quality and the *Cladium* fen habitat associated with the wetland complex there. Ballindooley Lough is upgradient from the proposed road development, in terms of groundwater flow, and there is therefore no potential for groundwater impacts to those areas of the wetland complex that support Alkaline fen habitat.

As a priority Annex I habitat type, negatively affecting surface water quality at the Ballindooley Lough wetland complex has the potential to degrade the *Cladium* fen habitat and potentially result in a likely significant residual effect, at the international geographic scale.

Mesotrophic lakes (FL4) and Eutrophic lakes (FL5)

These lakes form part of the larger wetland complex associated with Ballindooley Lough. Although direct impacts on the eutrophic lake that lies within the proposed road development are not likely to occur, run-off from the proposed development during construction has the potential to affect the quality of these lake habitats at Ballindooley. Similarly, the existing groundwater regime could be affected by works within that portion of the eutrophic lake that lies within the proposed road development and the hydrogeological ZoI.

Negatively affecting the habitat quality of these lakes has the potential to result in a significant residual effect at the county geographic scale.

Calcareous springs (FP1)

There were 21 Calcareous springs, not corresponding to the priority Annex I habitat Petrifying springs, recorded in Lackagh Quarry. Of these, 15 will be lost as a result of construction works: four in the vicinity of the eastern entrance to the Lackagh Tunnel, 9 along the northern wall of the quarry where material will be benched up against the cliff face as a stabilisation measure, and two south of the proposed mainline between Ch. 11+700 and Ch. 11+750. The loss of a large proportion of the springs within the quarry complex, particularly considering their scarcity locally, will result in a likely significant negative effect at the local geographic scale.

Reed and large sedge swamps (FS1)

The loss of a relatively small area (c.0.14ha) of what is a locally common habitat, supporting typical species of that habitat type (*Phragmites australis* reed swamp), is not likely to affect the long-term presence or viability of this habitat type locally. However, the proposed road development does have the potential to affect water quality at Ballindooley Lough which could affect a much larger area of this habitat type (c.3.6ha or 7.8% of the local habitat resource).

Therefore, the proposed road development has the potential to affect this habitat's conservation status and result in a likely significant negative effect at the local geographic scale.

Tall-herb swamps (FS2)

An area (c.0.03ha) of Tall-herb swamp at Ch. 3+400 will be permanently lost to the proposed road development. The loss of such a small proportion of what is a locally common habitat (c.0.8% of the c.4.09ha recorded locally within the habitat survey areas), supporting typical species of that habitat type (*Apium nodiflorum*, *Iris pseudacorus* and *Epilobium hirsutum*), is not likely to affect the long-term presence or viability of this habitat type locally. The percentage loss calculated is also likely to be an overestimate of the actual magnitude of habitat loss given the extensive wetland complex present beyond, and upstream of, the scheme study area at Coolanillaun and Tonacurragh.

Therefore, the proposed road development is not likely to affect this habitat's conservation status locally or result in a likely significant negative effect at the local geographic scale.

Eroding/upland rivers (FW1)

A full description of the hydrological baseline of each of the watercourses discussed below is provided in **Chapter 11, Hydrology**.

<u>Sruthán na Líbeirtí</u>

There is approximately 530m of Sruthán na Líbeirtí within, or along, the proposed development boundary. Of this, approximately 120m will be permanently lost to construction works, with the remaining length of stream channel located along the proposed development boundary and therefore, may be affected to some degree by construction works. The impact associated with the loss of instream habitat will be offset slightly by the creation of two new sections of stream channel, c.45m and c.40m in length. The impact associated with the loss of instream habitat will be further reduced by the creation of a new section of stream channel within the culvert structure, c.125m in length. As a seasonal stream in the upper reaches (where it is directly impacted by the proposed road development), with no fish species recorded during the fisheries surveys, the loss of natural stream channel habitat is not considered to be a likely significant negative effect at any geographic scale.

Impacts to water quality in Sruthán na Líbeirtí during construction however, have the potential to have a significant negative effect, at the local geographic scale.

<u>Trusky Stream</u>

The proposed road development will result in the loss of approximately 220m of the Trusky Stream channel during construction. The impact associated with the loss of instream habitat will be offset slightly by the creation of a new section of stream channel, c.65m in length. The impact associated with the loss of instream habitat will be further reduced by the creation of a new section of stream channel within the culvert structure, c.50m in length.

As a seasonal stream in the upper reaches (where it is directly impacted by the proposed road development), with no fish species recorded during the fisheries surveys, the loss of natural stream channel habitat is not considered to be a likely significant negative effect at any geographic scale.

Impacts to water quality in the Trusky Stream during construction however, have the potential to have a significant negative effect, at the local geographic scale.

<u>Bearna Stream</u>

There is approximately 345m of the Bearna Stream (and c.240m of its unnamed tributary) within, or along, the proposed development boundary. Of this, approximately 140m of the natural river channel will be permanently lost to construction works, with the remaining length of river channel located along the proposed development boundary and therefore, may be affected to some degree by construction works. The impact associated with the loss of instream habitat will be reduced by the creation of new sections of stream channel within the culvert structures, c.140m in length. As a seasonal stream in the upper reaches (where it is directly impacted by the proposed road development), with no fish species recorded during the fisheries surveys, the loss of natural stream channel habitat is not considered to be a likely significant negative effect at any geographic scale.

Impacts to water quality in the Bearna Stream during construction however, have the potential to have a significant negative effect, at the local geographic scale.

Tonabrocky Stream

Approximately 475m of the Tonabrocky Stream channel will be permanently lost to construction works. The impact associated with the loss of instream habitat will be offset slightly by the creation of a new section of stream channel, c.250m in length. The impact associated with the loss of instream habitat will be further reduced by the creation of a new section of stream channel within the culvert structure, c.80m in length.

As a seasonal stream in the upper reaches (where it is directly impacted by the proposed road development), with a low fisheries value, the loss of natural stream channel habitat is not considered to be a likely significant negative effect at any geographic scale.

Impacts to water quality in the Tonabrocky Stream during construction however, have the potential to have a significant negative effect, at the local geographic scale.

Knocknacarra Stream

The Knocknacarra Stream is of a low ecological value in its upper reaches, where it is directly affected by the proposed road development. It is seasonal with little water present in the upper reaches, heavily culverted along a significant proportion of its length (almost 50% - see **Section 11.3.5.4** of **Chapter 11, Hydrology**), and no fish were recorded here during the fisheries survey. Its fisheries value is limited to the tidal section at the estuary, after it emerges from an extensive culverted section.

Therefore, the loss of natural river channel habitat is not considered to be a likely significant negative effect, at any geographic scale.

Impacts to water quality in the Knocknacarra Stream during construction however, have the potential to have a significant negative effect, at the local geographic scale.

Depositing/lowland rivers (FW2)

A full description of the hydrological baseline of each of the watercourses discussed below is provided in **Section 11.3.5** of **Chapter 11, Hydrology**.

River Corrib

The potential for the proposed road development to impact upon the River Corrib is assessed in **Section 8.5.3.1** above and in the NIS.

Terryland River

The proposed road development will not have any direct impact on the Terryland River. As described in **Section 11.3.5.5** of **Chapter 11, Hydrology**, the proposed road development will not affect the flow regime of the Terryland River nor will it have any perceptible impact on water quality. The proposed N83 Flood Relief Measures will result in a slight increase in flood levels within the Terryland River channel, due to the discharge of flood waters into that catchment. However, the flood impact on the Terryland basin will only be slight given the extensive flood storage and flood area within this basin.

Considering the above, and that the Terryland River is heavily modified, with poor water quality and of a low fisheries value, the proposed road development will not result in a likely significant negative effect, at any geographic scale.

Drainage ditches (FW4)

The only notable network of drainage ditches in the eastern part of the study area are those associated with the wetland habitat complex at Ballindooley Lough. None of these features will be lost as a result of construction works although construction works in the vicinity pose a risk of affecting water quality and consequently the supported aquatic vegetation. In the western part of the study area, drainage ditches are a more common habitat; associated with the boundaries of wet grassland fields and the margins of the numerous heath and peatland habitat blocks. The design of the proposed road development includes for drainage pipes and structures that will maintain the functioning of drainage and surface water networks, where these are crossed by the proposed road development. Although the actual losses of drainage ditches cannot be fully quantified (for the most part due to their seasonal nature), given the likelihood of there being extensive drainage networks associated with the locally extensive heath, peatland and wetland habitat complexes, any losses associated with the proposed road development are not likely to affect the long-term presence or viability of this habitat type locally.

Therefore, the proposed road development is not likely to affect this habitat's conservation status locally or result in a significant negative effect at the local geographic scale.

Marsh (GM1)

The proposed road development will result in the loss of a small number of marsh areas at Na Foraí Maola Thiar, An Chloch Scoilte and Castlegar: totalling c.0.2ha. This equates to approximately 2.9% of this habitat type mapped within the scheme study area, a percentage which is likely to be an overestimate of the actual magnitude of habitat loss given the extensive wetland complex present beyond, and upstream of, the scheme study area at Coolanillaun and Tonacurragh. None of the surrounding marsh areas fall with the ZoI of potential hydrological or hydrogeological effects.

The affected habitat patches are small, isolated and do not form an integral part of any larger semi-natural mosaics. They also did not support any atypical or notable plant communities or species. The larger marsh areas recorded during the habitat surveys are associated with the wetland complex at Coolanillaun and these are beyond the ZoI of the proposed road development. Therefore, impacts on those areas that will be lost is not likely to affect the long-term presence or viability of this habitat type locally.

Therefore, the proposed road development is not likely to affect this habitat's conservation status locally or result in a significant negative effect at the local geographic scale.

Dry calcareous and neutral grassland (GS1)

The proposed road development will result in the permanent loss of c.13.7ha of Dry calcareous/neutral grassland, and c.1.55ha of a mosaic of Dry calcareous/neutral grassland and Scrub, valued as being of Local Importance (higher value). This equates to, at most, approximately 8.4% of the total area of Dry calcareous/neutral grassland habitat recorded within the scheme study area. However, based on a review or orthophotography of the surrounding local area (not covered within the extents of the habitat map) there is likely to be a much greater area of this habitat type present locally and the quoted 8.4% is likely to be an overestimate of the percentage habitat loss.

Therefore, the proposed road development is not likely to affect this habitat's conservation status locally or result in a significant negative effect at the local geographic scale.

Dry meadows and grassy verges (GS2)

The proposed road development will result in the permanent loss of c.8.2ha of dry meadows and grassy verges habitat valued as being of Local Importance (higher value). This equates to approximately 5.2% of the total area of acid grassland habitat recorded within the scheme study area. However, based on a review or orthophotography of the surrounding local area (not covered within the extents of the habitat map) there is likely to be a much greater area of this habitat type present locally and the quoted 5.2% is likely to be an overestimate of the percentage habitat loss.

Therefore, the proposed road development is not likely to affect this habitat's conservation status locally or result in a significant negative effect at the local geographic scale.

Dry-humid acid grassland (GS3)

The proposed road development will result in the permanent loss of c.7.81ha of Dry-humid acid grassland habitat valued as being of Local Importance (higher value).

The area of Dry-humid acid grassland habitat permanently affected is approximately 10.4% of the area of this habitat recorded locally. Additional areas of habitat would be expected to be present locally, associated with the margins of peatland habitat and low-intensity managed agricultural fields present to the north and west of the proposed road development in the western part of the study area. However, these areas are likely to be relatively small based upon its extent and distribution across the habitat mapped area and are not likely to significantly affect the relative percentage loss of this habitat type locally.

Accidentally introducing non-native invasive plant species into Dry-humid acid grassland habitat could also increase the extent and magnitude of road effects, degrading the habitat quality; as could an accidental pollution event or dust deposition during construction. During operation, air quality effects on Dry-humid acid grassland habitat in the vicinity of the proposed road development are not likely to affect plant species composition, diversity or abundance.

Therefore, the proposed road development is likely to affect this habitat's conservation status locally and result in a significant negative effect at the local geographic scale.

Wet grassland (GS4)

The proposed road development will result in the permanent loss of c.11.14ha of wet grassland habitat valued as being of Local Importance (higher value). This equates to approximately 4.7% of the total area of wet grassland habitat recorded within the scheme study area. However, based on a review or orthophotography of the surrounding local area (not covered within the extents of the habitat map) there is likely to be a much greater area of this habitat type present locally and the quoted 4.7% is likely to be an overestimate of the percentage habitat loss.

Therefore, the proposed road development is not likely to affect this habitat's conservation status locally or result in a significant negative effect at the local geographic scale.

Rich fen and flush (PF1)

The Rich fen and flush habitat along the River Corrib and associated with the Coolagh Lakes are within Lough Corrib cSAC and are assessed in the NIS, where relevant in relation to the QIs of the cSAC. There are no direct impacts on this habitat type in Lough Corrib cSAC. The proposed road development has the potential to affect both groundwater and surface water quality supporting wetland habitats in Lough Corrib cSAC.

Although there are no direct impacts on this habitat type at Ballindooley Lough, run-off from the proposed road development during construction has the potential to affect surface water quality and the rich fen and flush habitat associated with the wetland complex there. Ballindooley Lough is upgradient from the proposed road development, in terms of groundwater flow, and there is therefore no potential for groundwater impacts to those areas of the wetland complex that support rich fen and flush habitat.

As a priority Annex I habitat type, negatively affecting surface water quality at the Ballindooley Lough wetland complex has the potential to degrade the *Cladium* fen habitat and potentially result in a significant residual effect, at the international geographic scale.

Poor fen and flush (PF2)

The proposed road development will result in the direct, permanent loss of c.0.13ha of Poor fen and flush habitat. There will also be an additional indirect hydrogeology impact on the fen habit at Knocknafroska (Ch. 7+800 to Ch. 7+975) as a result of groundwater drawdown will result in an additional area of c.0.27ha being permanently affected.

The area of Poor fen and flush habitat permanently affected is approximately 18% of the area of this habitat recorded locally and has all been valued as being of a local importance (higher value). Additional areas of habitat would be expected to be present locally, associated with the expanses of peatland habitat present to the north and west of the proposed road development in the western part of the study area.

However, these areas are likely to be small based upon its extent and distribution across the habitat mapped area and are not likely to significantly affect the relative percentage loss of this habitat type locally.

Dust deposition during construction could also increase the extent and magnitude of road effects, degrading the habitat quality. During operation, air quality effects on Poor fen and flush habitat in the vicinity of the proposed road development are not likely to affect plant species composition, diversity or abundance.

Therefore, the proposed road development is likely to affect this habitat's conservation status locally and result in a significant negative effect, at the local geographic scale.

(Mixed) broadleaved woodland (WD1)

The proposed road development will result in the permanent loss of c.4.25ha of (Mixed) broadleaved woodland; equating to approximately 18.8% of the local resource of this habitat type. The most significant blocks of woodland affected are near the west bank of the River Corrib (Ch. 9+460 to Ch. 9+625) where one block of c.0.8ha and a second block of c.1.55ha of woodland will be lost (this second woodland block also lies within Lough Corrib cSAC). In terms of the potential Lough Corrib cSAC impact, this is discussed separately in **Section 8.5.3.1**, under the heading of Designated Areas for Nature Conservation, and in the NIS.

Accidentally introducing non-native invasive plant species into woodland habitat could also increase the extent and magnitude of road effects, degrading the habitat quality; as could an accidental pollution event or dust deposition during construction. During operation, air quality effects on woodland habitat in the vicinity of the proposed road development are not likely to affect plant species composition, diversity or abundance.

Even considering that much of the affected woodland blocks have been planted, many for amenity purposes, the loss (and fragmentation) of such a relatively large proportion of broadleaved woodland is likely to affect this habitat's conservation status locally and result in a significant negative effect at the local geographic scale.

Mixed broadleaved/conifer woodland (WD2)

The proposed road development will result in the permanent loss of c.0.03ha of Mixed broadleaved/conifer woodland at Ch. 1+580, next to the Troscaigh Road (L5387). This is part of a small woodland block (c.0.18ha) associated with the adjoining residential property. The habitat loss will not fragment the woodland nor is it likely to affect the long-term presence or viability of this habitat type locally, there are five other mixed broadleaved/conifer woodland blocks mapped within the scheme study area, totalling an area of c.2.75ha.

Therefore, the proposed road development is not likely to affect this habitat's conservation status locally or result in a significant negative effect at the local geographic scale.

(Mixed) conifer woodland (WD3)

The proposed road development will result in the permanent loss of <0.01ha of Mixed conifer woodland at Ch. 1+580, next to the Troscaigh Road (L5387). This is part of a small woodland block (c.0.05ha) associated with the adjoining residential property. The habitat loss will not fragment the woodland nor is it likely to affect the long-term presence or viability of this habitat type locally.

Therefore, the proposed road development is not likely to affect this habitat's conservation status locally or result in a significant negative effect at the local geographic scale.

Oak-ash-hazel woodland (WN2)

The proposed road development will result in the permanent loss of c.4.18ha of Oak-ash-hazel woodland; the majority of which is located near Menlough Village. This equates to approximately 1.8% of the total area of Oak-ash-hazel woodland mapped within the scheme study area.

Accidentally introducing non-native invasive plant species into woodland habitat could increase the extent and magnitude of road effects, degrading the habitat quality; as could an accidental pollution event or dust deposition during construction. During operation, air quality effects on woodland habitat in the vicinity of the proposed road development are not likely to affect plant species composition, diversity or abundance.

Although the area directly impacted is relatively small, the potential for indirect impacts could result in long-term impacts occurring and affecting a much greater area. Therefore, the proposed road development has the potential to affect this habitat's conservation status locally and result in a likely significant negative effect at the local geographic scale.

Scrub (WS1)

The proposed road development will result in the permanent loss of c.21.12ha of Scrub across the study area; the majority of which will occur between Bearna and Ballagh. This equates to approximately 5.3% of the total area of scrub habitat mapped within the scheme study area.

However, based on a review or orthophotography of the surrounding local area (not covered within the extents of the habitat map) there is likely to be a much greater area of this habitat type present locally and the quoted 5.3% is likely to be an overestimate of the percentage habitat loss. Dust deposition during construction could also increase the extent and magnitude of road effects, degrading the habitat quality. However, given the extent of this habitat type locally, this will not pose a risk to this habitats conservation status at a local level. During operation, air quality effects on scrub habitat in the vicinity of the proposed road development is not likely to affect plant species composition, diversity or abundance.

Therefore, the proposed road development is not likely to affect this habitat's conservation status or result in a significant negative effect at the local geographic scale.

Hedgerows (WL1)

The proposed road development will result in the permanent loss of c.7.8km of Hedgerow; the majority of which will occur in the eastern part of the study area.

Although there is not sufficient data to quantify the magnitude of hedgerow loss in a local context, it is likely that the extent and distribution of the habitat locally will be affected over the long-term. Particularly considering that Hedgerows are scarce or absent from much of the study area owing to the prevalence of stone walls as field boundaries and, in the western part of the scheme study area, extensive scrub encroachment.

Accidentally introducing non-native invasive plant species could increase the extent and magnitude of road effects, degrading the habitat quality; as could an accidental pollution event or dust deposition during construction. During operation, air quality effects on hedgerow habitat in the vicinity of the proposed road development are not likely to affect plant species composition, diversity or abundance.

Therefore, the proposed road development is likely to affect this habitat's conservation status locally and result in a significant negative effect, at the local geographic scale.

Treelines (WL2)

The proposed road development will result in the permanent loss of c.4km of Treelines along its length.

Although there is not sufficient data to quantify the magnitude of Treeline loss in a local context, it is likely that the extent and distribution of the habitat locally will be affected over the long-term; particularly considering the scarcity or absence of mature treelines within the study area.

Accidentally introducing non-native invasive plant species could increase the extent and magnitude of road effects, degrading the habitat quality; as could an accidental pollution event or dust deposition during construction. During operation, air quality effects on treeline habitat in the vicinity of the proposed road development are not likely to affect plant species composition, diversity or abundance.

Therefore, the proposed road development is likely to affect this habitat's conservation status locally and result in a significant negative effect, at the local geographic scale.

8.5.5 Rare and protected plant species

There are no rare or legally protected plant species present within the proposed development boundary. There are also no rare or legally protected plant species present in locations remote from the proposed road development that could be indirectly affected by impacts on the receiving hydrogeological or hydrological environments, through dust deposition, shading effects or through introducing/spreading non-native invasive plant species. Therefore, no impacts are predicted.

8.5.6 Mammals

8.5.6.1 Otter

8.5.6.1.1 Construction Phase Impacts

Although it cannot be predicted if Otter will establish new holt or couch sites within the ZoI of the proposed road development before construction works commence, it is a possibility and this scenario has been taken into account in the mitigation strategy (refer to **Section 8.6.7.1.1**).

Loss of breeding/resting sites

Based on the findings of the field surveys carried out, as there were no Otter breeding or resting places, holt or couch sites, present within the boundary of the proposed road development, there will not be any loss of holt or couch sites as a result of construction works.

Habitat Loss

In the context of rivers directly impacted by the proposed road development, Otter were recorded along the River Corrib and within the catchment of the Tonabrocky Stream.

In the context of river systems, the Threat Response Plan Otter *Lutra lutra* 2009-2011 document (Department of the Environment, Heritage and the Gaeltacht, 2011) defines terrestrial Otter habitat as a 10m zone of riparian habitat along the river banks. On all watercourses crossed by the proposed road development, bar the River Corrib, construction works will result in the permanent loss of some level of riparian vegetation; primarily within the construction footprint of the crossing structure (or temporary crossing structures) but also, in many cases, to construct the drainage outfalls to the surface water network. Instream habitat will also be lost, or be highly modified, as a result of construction works to install culverts. The level of permanent habitat loss will be greatest on watercourses where stream realignments are proposed as part of the design: Sruthán na Líbeirtí, the Trusky Stream and the Tonabrocky Stream.

On the River Corrib, the construction of the proposed bridge structure will not result in the loss of any instream habitat nor will it result in the permanent loss of Otter habitat on the west or east bank of the river within 5m of the river bank. Nevertheless, some vegetation cutting/removal would likely be required to facilitate the construction works and on an ongoing basis as part of the maintenance works associated with the proposed road development during operation. Some effects to any remaining vegetation underneath the bridge structure would also be expected as a result of shading effects. The construction of the drainage outfalls to the River Corrib will, however, result in the loss of approximately 3m of riparian habitat on each bank.

Habitat losses of such a comparatively small scale, in the context of the instream and riparian habitat resource in all surface water catchments crossed by the proposed road development which support Otter, would not constitute a significant decline in the extent of available Otter habitat and will not affect the local Otter population's ability to maintain itself, even in the short-term. Even in a case where it would be partially converted to hard surfaces, such as where a precast concrete culvert is installed, Otter routinely use highly modified habitat within culverts and beneath bridges.

Habitat loss associated with the construction of the proposed road development will not have a likely significant effect on the conservation status of Otter and will not have a likely significant negative effect, at any geographic scale.

Habitat degradation - water quality

During construction, contaminated surface water runoff and/or an accidental spillage or pollution event into any surface water feature has the potential to have a significant negative impact on water quality and consequently an impact on Otter; either directly (e.g. acute or sub-lethal toxicity from pollutants) or indirectly (e.g. affecting their food supply or supporting habitats). The effects of frequent and/or prolonged pollution events in a river system have the potential to be extensive and far-reaching and could potentially have significant long-term effects.

However, it is considered unlikely that a pollution event of such a magnitude would occur during construction, or be any more than temporary in nature. Nevertheless, a precautionary approach is being taken in assuming a level of risk of water quality impacts and detailed mitigation measures are required to further minimise the risk of the proposed road development having any perceptible effect on water quality during construction.

Habitat degradation as a result of effects on surface water quality during construction has the potential to affect the species' conservation status and result in a likely significant negative effect, at a local geographic scale. Mitigation measures have been designed to protect water quality during construction (see **Section 8.6.4**).

Habitat Severance/Barrier Effect

The physical disturbance to the stream/river channels and the associated riparian margins will result in the severance of river habitat, at least temporarily, during construction. This may also result in some level barrier effect during construction works, on all watercourses.

However, given that Otter are generally nocturnal in habitat and works will typically be carried out during normal daylight working hours, affected Otters would be expected to habituate to the altered landscape and any resulting barrier effect would be temporary in nature (see below on disturbance/displacement and the habituation of Otters to disturbance).

The severance/barrier effect of construction works on Otter is not likely to affect the local population, over even the short-term, and is not likely to affect the species conservation status and result in a significant negative effect, at any geographic scale.

Disturbance/displacement

There were no Otter breeding or resting places present within the ZoI of the proposed road development. Therefore, there will not be any disturbance or displacement effect on such sites associated with construction works.

Otter were recorded widely along the River Corrib corridor, and in the Tonabrocky Stream catchment, and therefore increased human presence and/or noise and vibration associated with construction works, has the potential to (at least temporarily) displace commuting or foraging Otter.

Otter are known to tolerate human disturbance, including road traffic, under certain circumstances (Bailey & Rochford, 2006, The Environment Agency, 2010, Irish Wildlife Trust, 2012). This is also evidenced by the presence of Otter signs along the River Corrib through the NUIG Campus (see **Figures 8.3.1** to **8.3.14**[64]), the presence of an active Otter couch site within 50m of the Quincentenary Bridge, and the presence of Otter (including holt sites) in the urban centre of Galway City.

As construction works will typically be undertaken during normal daylight working hours and Otter are generally nocturnal in habit, and that Otter can (in many circumstances) tolerate high levels of human presence and disturbance, displacement of Otter from their habitat is extremely unlikely to affect the local Otter population. Therefore, disturbance during construction is not likely to have a significant effect on the species' conservation status and will not result in a likely significant negative effect, at any geographic scale.

8.5.6.1.2 Operational Phase Impacts

Habitat Severance/Barrier Effect

The installation of new culverts or bridge structures has the potential to result in a permanent barrier to Otter movement along watercourses crossed by the proposed road development. Particularly during periods of spate flow or flooding, where increased water volumes and flow rates may render the structure impassable by Otter.

In the case of the proposed River Corrib Bridge, this impact will not arise as it is a clear span structure and will not affect the existing hydrological regime or functioning of the floodplain (see **Chapter 11, Hydrology**). Therefore, the Otter population associated with the River Corrib (and thus Lough Corrib cSAC) will not be affected in this regard. However, on all other watercourses (whether used by Otter at present, such as the Tonabrocky Stream, or not) the risk of the crossing structure resulting in a barrier effect is possible.

[64] There is a distinct difference in recorded levels of Otter signs/activity between the west and east banks of the River Corrib in the vicinity of the proposed River Corrib Bridge; with Otter clearly favouring the east bank of the River Corrib than that on the side of NUIG Sporting Campus. Although whether this is as a result of the west bank being more accessible to the public (and hence subject to higher levels of disturbance, particularly due to the presence of dogs), as a result of the open, and sparsely vegetated, nature of the riparian margin on the west bank, or some combination of the two, is unknown.

The habitat severance/barrier effect to Otter associated with the proposed road development has the potential to affect local Otter populations over the long-term, potentially affecting the species' conservation status, and result in a likely significant negative effect, at a local geographic scale. Mitigation measures to maintain mammal passage along watercourses used by Otter have been designed (see **Section 8.6.7.1.2**).

Disturbance/displacement

As discussed above in relation to construction impacts, Otter can be relatively tolerant of human and traffic disturbance. Any increased level of disturbance associated with the operation of the proposed road development is therefore, extremely unlikely to result in any perceptible disturbance/displacement of Otter from their habitat.

Nocturnal mammals, such as the Otter, would be likely to be disturbed by the introduction of artificial light into established breeding and foraging areas (Rich & Longcore, 2005).

Lighting will be provided for the proposed NUIG Sports Pitches. Whist there is planning permission to floodlight the existing pitches adjacent to the river, they are currently unlit. There is no holt located within or near the area of light spill from the proposed lighting for the proposed NUIG Pitches. The light spill will not impede Otter from using the River Corrib for feeding or commuting.

There will be no light spill to any other watercourses where Otter were recorded and there will not be any impacts in that regard.

Disturbance or displacement associated with the operation of the proposed road development is not likely to affect the conservation status of Otter and therefore, will not result in a likely significant negative effect, at any geographic scale.

Habitat degradation - water quality

There will be outfall points to surface water features from the road drainage network during operation. The proposed drainage design for the mainline of the proposed road development incorporates pollution control measures (this includes petrol interceptors, wetland and other measures, such as SuDS) followed by either infiltration ponds (where discharging to ground) or attenuation ponds (where drainage will be discharged to the existing surface water/storm sewer), as described in detail in **Chapter 5, Description of Proposed Road Development**.

Those sections of the road drainage that are to be discharged to ground, pose no risk to surface water quality. It is extremely unlikely that the normal operating water quality of the drainage outfalls discharging to the existing surface water/drainage network, even in the unlikely event of a pollution incident, would have any perceptible impact on water quality in receiving watercourses. The functioning and effectiveness of both elements of the road drainage network are discussed in more detail in **Chapter 11, Hydrology**.

Habitat degradation as a result of effects on surface water quality during operation is not likely to have any effect on the Otter population or its conservation status, and therefore will not result in a likely significant negative effect, at a local geographic scale.

Mortality Risk

The introduction of the proposed road development into a rural landscape, which includes new watercourse crossings, will permanently increase the risk of road traffic collisions with Otter; particularly where Otter have been recorded (see **Figures 8.3.1** to **8.3.14**). The exceptions to this are along the River Corrib, where the proposed road development is elevated above the river and floodplain such that it would not be accessible by Otter, and the Menlough Viaduct which is elevated above the turlough at Ch. 10+320.

Although it is not possible to quantify the magnitude of the effect, the increased collision risk has the potential to result in long-term effects on Otter populations locally, potentially affecting their local conservation status.

Collision risk to Otter associated with the proposed road development has the potential to result in a likely significant negative effect, at the local geographic scale. Mitigation measures have been designed to avoid this potential impact (see **Section 8.6.7.1.2**).

8.5.6.2 Bats

This section of the impact assessment deals with impacts on bats species. Firstly, it describes the different types of impacts that could potentially affect all bat species and then secondly deals with the potential impacts on each species individually.

8.5.6.2.1 Construction Phase Impacts

Roost Loss

Fifteen buildings supporting 20 bat roosts are within the proposed development boundary (6 Soprano pipistrelle roosts (PBR177, 179, 196, 205, 255, 267), 1 Common pipistrelle roost (PBR205), 1 unidentified Pipistrelle bat roost (PBR182), 7 Brown long-eared bats roosts (PBR 183, 178, 179, 196, 204, 256, 267), 3 Lesser horseshoe bat roosts (PBR178, 204, 210) and two unidentified species bat roosts (253, 270). Six of these are structures used by more than one bat species. **Figures 8.18.1** to **8.21.1** show the locations of these roosts.

Fourteen of these structures are proposed for demolition (see **Table 8.28** below), with one of the structures (PBR241) to be retained, protected from adverse impacts and bat roost features fitted to the structure. One structure (PBR183) will be demolished but an outbuilding will be retained for the purposes of compensation for loss of other roosts.

Table 8.28: Bat roosts to be removed as part of the proposed road development

Approx. Chainage	Roost reference	Roost type
Ch. 5+550	PBR267	Building. Roost for small numbers of Soprano pipistrelle and Brown long-eared bats (likely to be a transition/occasional roost)
Ch. 8+600	PBR256	Building. Brown long-eared maternity roost.
Ch. 8+650	PBR255	Building. Roost for small numbers of Soprano pipistrelle bats (likely to be a transition/occasional roost)
Ch. 8+650	PBR178	Building. Lesser horseshoe bat roost. Juvenile bats present late in the maternity season but not proven to be a maternity roost. Loss of maternity roost for Brown long-eared bats
Ch. 8+700	PBR177	Building. Roost for small numbers of Soprano pipistrelle bats (likely to be a transition/occasional roost)
Ch. 8+750	PBR210	Building. Lesser horseshoe bat night roost
Ch. 10+050	PBR179	Building. Roost for small numbers of Soprano pipistrelle and Brown long-eared bats (likely to be a transition/occasional roost)
Ch. 11+400	PBR253	Building. Roost for small numbers of unidentified bats (likely to be a transition/occasional roost)
Ch. 12+150	PBR204	Building. Lesser horseshoe bat and Brown long-eared bat day/night roost for small numbers of bats
Ch. 12+150	PBR182	Building. Roost for small numbers of unidentified Pipistrelle bats (likely to be a transition/occasional roost)
Ch. 12+150	PBR196	Building. Roost for small numbers of Soprano pipistrelle and Brown long-eared bats (likely to be a transition/occasional roost)
Ch. 12+960	PBR183	Building. Roost for small numbers of Brown long-eared bats (likely to be a transition/occasional roost)
Ch. 15+100	PBR205	Building. Roost for small numbers of Common and Soprano pipistrelle bats (likely to be a transition/occasional roost)
Ch. 15+250	PBR270	Building. Roost, possibly abandoned. Unidentified species

Two trees will be felled (PTR48, PTR43) that have been confirmed as supporting bats (Leisler's bat and Soprano pipistrelle bat respectively) and an additional 13 trees have high (category 1) potential to support bats and will also be felled. **Figures 8.16.1** to **8.16.15** show the locations of these trees.

The potential impacts of the permanent loss of these 14 roost structures, apart from the Lesser horseshoe bat roosts, and the two trees are deemed to be significant at a local level as they are valued as important at the local geographic level, almost all had a low number of bats using them and were recorded using other roost sites across the study area which will not be impacted by the proposed road development.

The impacts of the loss of the Lesser horseshoe bat roosts are potentially significant at a national level in the absence of mitigation measures. Evidence confirms that the roost at Aughnacurra (PBR178) is a satellite roost linked to Menlo Castle. Given that the physical structure of the Menlo Castle roost may be deteriorating, the Aughnacurra roost could be a relatively new addition to their network of roosts. The Aughnacurra satellite roost (PBR178) is within a sub-optimal building in terms of the preferred building type for this species and its occupation by bats may be a reflection of the lack of availability of better roost opportunities in the area.

Therefore, the loss of the satellite Lesser horseshoe bat roost at Aughnacurra (PBR178) and the loss of other Lesser horseshoe bat night roosts (PBR204, PBR210) within their foraging area could result in a likely significant effect on the Lesser horseshoe bat at a national geographic scale, in the absence of any measures to address this impact.

In the context of the potential impact on the Lough Corrib cSAC, of which Lesser horseshoe bats are a QI, although this species is present within the study area, the roost that forms the QI population for this European site (Eborhall House) is more than 30km away from the proposed road development, on the northern shore of Lough Corrib. This distance would be regarded to be beyond the normal core foraging range of the Eborhall House population and beyond the normal commuting range of this species except on exceptional occasions or over long periods of time – for example, bats dispersing and moving between areas in the wider landscape over a period of many years/generations. Furthermore, radio-tracking surveys of the Menlough population of bats (which were identified within the study area) undertaken for this project in 2014 and 2015 (*N6 Galway City Transport Project Route Selection Report*, Arup, 2016) did not suggest any evidence of movement between that population and the Eborhall House roost. Given the lack of any linkage between the study area and the roosts that are the reason for designation of this European site, likely significant effects on the Lough Corrib cSAC's Lesser horseshoe bat population have been ruled out.

Twelve other bat roosts were deemed to be in close proximity to the proposed road development (within 100m) of the proposed development boundary. Potential direct impacts are predicted on these roosts as a result of disturbance during the construction phase, although it is acknowledged that in some areas this impact may be of a lower magnitude than others as the boundary is set back from the actual construction footprint.

These roosts include night roosts for Lesser horseshoe bats, day roosts for Soprano and Common pipistrelle bats, Leisler's bats and a possible maternity roost for Brown long-eared bats. This is predicted to result in a likely significant effect at a local geographic scale for all of these species, in the absence of mitigation. **Table 8.29** describes these roosts.

Only PBR173 and PBR154 are suspected to be vulnerable to a significant level of construction impacts. PBR173 is a suspected maternity roost for Brown long-eared bats and PBR154 is a known night and occasional day roost for small numbers of Lesser horseshoe bats alongside the N84 Headford Road. All other roosts are set back from the proposed development boundary or are in locations where the construction works for the proposed road development are less likely to be as intrusive.

The species that is potentially incurring the greatest potential loss of roosting is the Soprano pipistrelle bat population, which also happens to be the most commonly occurring bat in the country and recorded at almost all recording locations in the study area.

The impact on population of Lesser horseshoe bats lost as a result of demolition comes from the loss of one property at Aughnacurra (PBR178), a satellite roost to Menlo Castle (PBR06) (which itself will not be affected by the demolition works).

Table 8.29: Bat roosts adjacent to the proposed road development or known to be used by bats that cross the proposed road development

Approx. Chainage	Roost reference	Roost type
Ch. 1+600	PBR225	Building. Possible maternity roost for Soprano pipistrelle bats, Brown long-eared bats also present
Ch. 4+500	PBR139	Building. Roost for small numbers of Leisler's bats
Ch. 7+400	PBR49	Building. Roost for small numbers of Soprano pipistrelle and Brown long-eared bats (likely to be a transition/occasional roost)
Ch. 8+150	PBR173	Building. Possible maternity roost for Brown long-eared bats, small roost
Ch. 0+50 N59 Link Road North	PBR73	Church. Historical record of Natterer's roost
Ch. 9+375	PBR06	Menlo Castle. Maternity roost for Lesser horseshoe bat. Also roost for Daubenton's bats
Ch. 9+700	PBR156	Gateway arch. Night roost for Lesser horseshoe bats and Brown long-eared bats
Ch. 10+050	PBR219	Limestone feature. Night roost for Lesser horseshoe bats
Ch. 10+700	PBR129	Building. Lesser horseshoe bat night roost
Ch. 10+700	PBR85	Building. Lesser horseshoe bat night roost
Ch. 12+150	PBR154	Building. Lesser horseshoe bat night roost
Ch. 13+000	PBR145	Building. Possible maternity roost for Brown long-eared bats, small roost
Ch. 13+000	PBR153	Building. Lesser horseshoe bat day/night roost
Ch. 13+600	PBR192	Building. Roost for small numbers of Brown long-eared bats (likely to be a transition/occasional roost)
Ch. 13+900	PBR228	Building. Roost for small numbers of Common pipistrelle bats (likely to be a transition/occasional roost)

Approx. Chainage	Roost reference	Roost type
Ch. 14+450	PBR242	Building. Roost for small numbers of unidentified Pipistrelle bats (likely to be a transition/occasional roost)
Ch. 13+000	PBR54	Building. Day/night roost for small numbers of Lesser Horseshoe bats. This roost is linked to the Menlo Castle roost and Cooper's Cave
Ch. 13+100	PBR112	Cooper's Cave. Day/night roost for small numbers of Lesser Horseshoe bats. Mating, summer and hibernacula. This roost is linked to Menlo Castle and bats cross the proposed road development in several places when moving between the two roosts

The potential impacts on these roosts varies considerably as it depends on the degree of linkages between the roost and the proposed road alignment, the degree of severance of connecting features, potential effects of light spill etc. These impacts are therefore addressed in the relevant sections below. Mitigation to protect bats during the removal of roosts are detailed in **Section 8.6.7.2.1**.

Habitat Loss

Bats rely on suitable semi-natural habitats which support the insect prey upon which they feed. The proposed road development will result in the loss of such habitats used for feeding by all bat species recorded in the study area. The studies of several different species as part of the collection of baseline data has demonstrated that more open habitats including pastures, open heathland and suburban gardens are also used by bats. Therefore, there are actually very few areas within the corridor of the proposed road development that are considered unsuitable for bats. These would be restricted to locations where the proposed road development crosses main roads and connects to the existing dual carriageway near Oranmore. All other locations are potentially used by bats.

The direct loss of foraging habitats will have an adverse effect on the individual bats that have been using these areas as it represents a loss of feeding resources. Where these feeding resources are close to roosts it may lead to decline in use of the roosts as bats tend to feed close to roost especially prior to giving birth when they need to save energy. Scientific data has been collected so that the extent of the foraging habitat used by the Lesser Horseshoe bats roosting at Menlo Castle has been determined. However, for other confirmed roosts the extent of the foraging habitats can only be estimated. Scientific data on the mean size of foraging areas for each species was sourced from research literature and was used to identify likely core foraging areas for the other species of bats.

The UK Bat Conservation Trust (BCT) has published research results on the identification of Core Sustenance Zones (CSZs) for different bat species. A CSZ refers to the area surrounding a communal bat roost within which habitat availability and quality will have a significant influence on the “resilience and conservation status” of the colony using the roost. The 2016 guidance states that:

"*With reference to planning and development the core sustenance zone is:*

- *The area surrounding the roost within which development work can be assumed to impact the commuting and foraging habitat of bats using the roost, in the absence of information on local foraging behaviour. This will highlight the need for species-specific survey techniques where necessary.*
- *The area within which mitigation measures should ensure no net reduction in the quality and availability of foraging habitat for the colony, in addition to mitigation measures shown to be necessary following ecological survey work."*

The core sustenance zone for the Irish bat species are listed below in **Table 8.30** with an indication of the level of confidence attached to the zone size.

Table 8.30: Bat roosts adjacent to the proposed road development and CSZ

Species	CSZ radius (km)	Confidence in zone size
Lesser horseshoe bat	2-3	Good: The CSZ in the context of the roost at Menlo Castle and at Coopers Cave is regarded to be 3km (mean maximum foraging distance 2.93km in August 2014, 3.39km in August 2014, 2.86km in May 2015). This has been calculated using the same approaches as outlined in the BCT guidance. In the context of other day roosts the CSZ of 2km has been applied.
Brown long-eared bat	3	Poor. No data on mean-maximum distance between roost and foraging areas available from the literature. In addition, the calculated weighted average (based on the number of bats used to calculate the CSZ) (3.45km) lies just below the threshold where it was rounded down to give a CSZ size of 3km. The CSV of the Brown Long-eared bat that was studied during radio-tracking in 2014 is regarded to be approximately less than 4km radius (maximum foraging distance was 4.07km but data collection only took place over 2 days). Since only one bat was tracked, the BCT recommended CSZ distance of 3km has been used.
Daubenton's bat	4	Poor. No data on mean-maximum distance between roost and foraging areas available from the literature. In addition, the calculated weighted average (based on the number of bats used to calculate the CSZ) (3.5001km) lies just above the

Species	CSZ radius (km)	Confidence in zone size
		threshold where it was rounded up to give a CSZ size of 4km. The maximum foraging distances of the Daubenton's bats that were studied has shown a limited feeding area within the Corrib corridor up to 2.5km from the roost. Due to the low numbers of bats that were analysed the BCT recommended CSZ distance of 4km has been used.
Natterer's bat	4	Good. Calculation based on a reasonable sample size from multiple colonies and studies.
Whiskered bat	1	Poor. Data available from multiple colonies but only for a single study for M. mystacinus.
Common pipistrelle bat	2	Moderate. Data available from multiple colonies but only from a single study.
Soprano pipistrelle bat	2	Good. Calculation based on a reasonable sample size from multiple colonies and studies.
Nathusius' pipistrelle bat	3	Poor. Calculation based on small sample size.
Leisler's bat	4	Poor. Calculation based on small sample size.

Unidentified bats have been given a CSZ radius of 3km which represents the average of the above CSZ radii.

For all confirmed roosts that were identified during the field surveys, the proportion of the CSZ that will be lost as a result of the proposed road development was calculated (refer to **Appendix E** for details). Whilst the CSZ is a generic radial distance from the roost, in some cases not all of this habitat would be regarded to be suitable foraging habitat for bats as it included built land with little suitable habitat to provide foraging resources. Bats will therefore not use all of the CSZ; they will selectively feed in the most resource-rich areas. However, such potentially unsuitable areas within the footprint of the proposed road development were not deducted from the CSZs for each roost, thereby giving a worst-case scenario for the assessment of impacts. CSZs around night roosts have not been included in this analysis as theoretically these roosts occur within the CSZ of the associated day roost.

The level of significance of the loss of these habitats is described in terms of impacts on individual roosts and then on the patterns of bat foraging as suggested by the bat activity data.

It is important to note that the percentage loss of area within the CSZ does not account for any additional barrier effects provided by the road which could prevent bats reaching foraging areas on the other side of the proposed road development. Research by Berthinussen and Altringham (2012a, 2012b, 2015) has identified landscape-scale reductions in bat activity and diversity as a result of the construction of road developments in the UK. Whilst barrier effects and severance of flight paths has been clearly demonstrated, the causes of displacement of bats from the margins of the corridor of the proposed road development are less clear. (Also see Bontadina et al. (2002), Reiter et al., (2013), CALTRANS (July 2016): *Technical Guidance for the Assessment and Mitigation of the Effects of Traffic Noise and Road Construction Noise on Bats*, Luo et al., (2015)).

The scale of significance of habitat loss during construction was therefore influenced by:

- the nature of the roost (transition/occasional roost occasionally used by small numbers of bats compared to maternity roosts for larger numbers of bats)
- Records of bats within the CSZ indicating concentrations of feeding within the CSZ which could suggest some areas being more important than others
- Proportion of suitable habitat within the CSZ
- Potential for the proposed road development to form a barrier to reaching the remaining portions of the CSZ (i.e. whilst the loss of CSZ may be very small, bats may not be able to reach it and consequently a larger proportion of the CSZ may actually be unavailable)

Table 8.31 describes the scale of the loss of habitats within the theoretical CSZ for each bat roost within the proposed development boundary. **Table 8.32** describes the scale of habitat loss associated with bat roosts which will not be removed as a consequence of the proposed road development.

Table 8.31: Extent of direct habitat loss within the theoretical core sustenance zone relating to the roosts within the proposed development boundary (* takes into account that c.10ha of foraging habitat is being retained intact within the boundary of the proposed road development at Menlough)

Approx. Chainage	Roost reference	Species	Area of habitat loss within the CSZ	% of CSZ	Likely significance of Impact of habitat loss
Ch. 3+320	PBR241 (Building to be retained)	Soprano pipistrelle bats	37ha	2.95%	The CSZ includes Bearna Woods on the opposite side of the road though access may be severed by the proposed road development. This species has been recorded to the north west where there is good foraging habitat available. Habitat unlikely to be a limiting factor in the locality. Due to the small size of the roost, the availability of suitable foraging habitat and the lack of evidence for severance of key roost attributes this impact is likely to result in a significant negative effect at a local geographic scale only.
Ch. 5+550	PBR267	Soprano pipistrelle bats Brown Long-eared bats	46ha 79ha	3.66% 2.79%	The CSZ includes a large proportion (estimated at >30%) of built land which is unlikely to actually be part of the CSZ. Brown long-eared bats have been recorded at 3 other locations to the north and west where there is good foraging habitat available. Habitat unlikely to be a limiting factor in the locality. Due to the small size of the roost, the availability of suitable foraging habitat and the lack of evidence for severance of key roost attributes this impact is likely to result in a significant negative effect at a local geographic scale only.
Ch. 8+600	PBR256	Brown Long-eared bats (maternity)	100ha*	3.54%	The CSZ includes a mixture of suburban, dense urban and rural landscapes. A large proportion of the CSZ area is of low suitability and this is to the south (opposite side) of the proposed road development. Few records of this species are found south of the road so it is predicted that bats in this

Approx. Chainage	Roost reference	Species	Area of habitat loss within the CSZ	% of CSZ	Likely significance of Impact of habitat loss
					roost are likely to rely on the local wooded suburbs in Aughnacurra, Glenlo Abbey and Menlough Village and are likely to use the unlit River Corrib corridor to move across the local landscape. The N59 Moycullen Road is currently likely to present a degree of barrier effect to regular movements as it is illuminated by pole mounted lights. Bats will also be able to continue using the unlit Corrib river corridor during the construction phase. Overall, the impact of habitat loss during construction is likely to result in a significant negative effect at a local geographic scale since these bats will be able to utilise the majority of suitable habitat in the CSV that is currently available to them.
Ch. 8+620	PBR178	Lesser horseshoe bat Brown long-eared bats	64ha* 101ha*	5.1% 3.57%	Lesser horseshoe bats: The radio-tracking studies did not record any of the tagged bats using this roost so it cannot be stated with confidence these bats use the same foraging areas as the bats from Menlo Castle/Cooper's Cave. However, it would be reasonable to assume that they prefer similar habitats including woodland, scrub, suburban gardens and wetlands. The loss of the habitats for any remaining bats is likely to result in a significant negative effect at a local geographic scale, as the proportion of suitable habitat within the CSZ is predominantly to the north away from the proposed road development. Despite several studies in the NUIG Campus to the south of the road, the records of Lesser horseshoe bats there appears to be relatively few and perhaps limited by the open landscape and effects of public lighting nearby.

Approx. Chainage	Roost reference	Species	Area of habitat loss within the CSZ	% of CSZ	Likely significance of Impact of habitat loss
Ch. 8+650	PBR255	Soprano pipistrelle bats	64ha*	5.1%	The CSZ includes a mixture of suburban, dense urban and rural landscapes. A large proportion of the CSZ area is of low suitability and this is to the south (opposite side) of the proposed road development. Few records of this species are found south of the road so it is predicted that bats in this roost are likely to rely on the local wooded suburbs in Aughnacurra, Glenlo Abbey and Menlough Village and are likely to use the unlit River Corrib corridor to move across the local landscape. The N59 Moycullen Road is currently unlikely to present a degree of barrier effect to regular movements as this species is recorded on both sides. Bats will also be able to continue using the unlit River Corrib corridor during the construction phase. Overall, the impact of habitat loss during construction is likely to result in a significant negative effect at a local geographic scale since these bats will be able to utilise the majority of suitable habitat in the CSV that is currently available to them and are not reliant on having to cross the construction area to reach foraging areas.
Ch. 8+700	PBR177	Soprano pipistrelle bats	65ha*	5.18%	The CSZ includes a mixture of suburban, dense urban and rural landscapes all of which may be utilised by this species. A large proportion of the CSZ area is of lower suitability and this is to the south (opposite side) of the proposed road development. This species has been recorded widespread across its theoretical CSZ. The N59 Moycullen Road is currently unlikely to present a degree of barrier effect to regular movements as this species is recorded. Bats will also

Approx. Chainage	Roost reference	Species	Area of habitat loss within the CSZ	% of CSZ	Likely significance of Impact of habitat loss
					be able to continue using the unlit Corrib river corridor during the construction phase. Overall, the impact of habitat loss during construction is likely to result in a significant negative effect at a local geographic scale, since these bats will be able to utilise the majority of suitable habitat in the CSV that is currently available to them and are not reliant on having to cross the construction area to reach foraging areas.
Ch. 10+050	PBR179	Soprano pipistrelle bats Brown long-eared bats	75ha 116ha	5.97% 4.1%	The CSV for both species includes the River Corrib which appears to be an important feature for bats and will not be affected in terms of habitat loss or its function as a corridor to permit passage to other foraging areas. The loss of the foraging habitats near the roost is a small proportion of that located in the surrounding area and it is unlikely the loss will result in a significant negative effect any greater than at the local geographic scale. Foraging opportunities will still be available on both sides of the proposed road development immediately adjacent to the fenceline for both species so if there is a barrier effect caused during construction then this is unlikely to translate into a decline in foraging close to the road.
Ch. 11+400	PBR253	Unidentified bats	122ha (3km radius CSZ)	4.32%	The CSZ is centred over Lackagh Quarry which itself offers little suitable feeding habitat but clearly, as suggested by the radio-tracking and use of unattended detectors, was used by seven species of bats. Areas of open water and the shelter offered by the quarry walls may offer good conditions for feeding. The area of the proposed road development will use all of the quarry area during construction but the topography

Approx. Chainage	Roost reference	Species	Area of habitat loss within the CSZ	% of CSZ	Likely significance of Impact of habitat loss
					of the quarry lend itself to providing linear “guides” across the construction area. Given that the roost itself is unlikely to harbour large numbers of bats, it is likely that the roost does not rely on the immediate surrounding habitat. Therefore, the loss of the habitat is not likely to result in a significant negative effect any greater than at the local geographic scale.
Ch. 12+150	PBR204	Lesser horseshoe bats Brown long-eared bats	76ha (2km radius CSZ) 126ha	6.05% 4.46%	The immediate surroundings of the roost are the detached dwellings and other properties fronting the N84 Headford Road. The surrounding habitats are deemed to be of moderate suitability for both species but better to the north than toward the city to the south. The loss of the habitat is unlikely to manifest itself in a loss of foraging resources as habitats to the north will still be accessible. However, this section was identified as a location where Lesser horseshoe bats cross the width of the alignment and thereby the loss of the connecting habitats could restrict movements for some of the bats from the Menlo Castle/Cooper’s Cave roosts. This barrier effect caused by habitat loss could cause a potential impact predicted to be significant at a National geographic scale in the absence of mitigation due to the importance of this crossing point for Lesser horseshoe bats at this location. The impact on Brown long-eared bats is likely to result in a significant negative effect at a local geographic scale due to the more widespread occurrence of this species in the CSZ as suggested by the other survey results.

Approx. Chainage	**Roost reference**	**Species**	**Area of habitat loss within the CSZ**	**% of CSZ**	**Likely significance of Impact of habitat loss**
Ch. 12+150	PBR182	Unidentified pipistrelle bats	126ha	4.46%	This roost was not deemed to be a currently active roost and only two droppings were found so the effects of habitat loss of this roost is likely to, at most, result in a significant negative effect at a local geographic scale.
Ch. 12+150	PBR196	Soprano pipistrelle Brown long-eared bats	78ha 126ha	6.21% 4.46%	This roost hosts a single bat or small numbers of both species. Its theoretical CSZ includes stretches from the River Corrib in the west to the Galway Racecourse to the east and includes habitats of high suitability mostly in the northern half and around the Coolagh Lakes. In reality, the likely CSZ does not include the most built-up areas of developed lands to the south and probably includes Ballindooley Lough and its network of hedgerows. The loss of the roost and the habitats within the theoretical CSZ is unlikely to affect the local population of both species which will still have plenty of foraging habitat available. They are also less likely to be significantly affected by the barrier effects posed by the habitat loss due to the small numbers of bats involved.
Ch. 12+960	PBR183	Brown long-eared bats	118ha	4.17%	The habitats closest to this suspected transition/occasional or night roost for this species were relatively open and not regarded to be optimal feeding habitat for this species. The likely CSZ would be expected to exclude lands to the southwest toward Ballinfoyle which are more built up and be skewed toward the rural landscape to the north and west. Since there will be plenty of foraging habitats available to the local bat population for this species, the only impact that could potentially be significant could be caused by the barrier effect of removal of connecting landscape features. Bats of this species that were radio-tracked in 2014 (bat no.

Approx. Chainage	Roost reference	Species	Area of habitat loss within the CSZ	% of CSZ	Likely significance of Impact of habitat loss
					5) generally stayed to the south of the proposed road development footprint.
Ch. 15+100	PBR205	Common and Soprano pipistrelle bats	92ha	7.32%	Bats in this roost at the racecourse are likely to have their CSZ encompassing lands to the east and the west as suggested by the suitable habitats found there and bat detector records for both species in these areas. The CSZ is unlikely to stretch to the southwest due to lack of suitable habitats there so even if there is a barrier effect caused by habitat loss there is not likely to be a significant negative effect.
Ch. 8+750	PBR210	Lesser horseshoe bat	NA	NA	Night roost for Lesser horseshoe bats. Since this is within the range of a day roost (likely to be PBR178 or PBR06) the impact on the CSZ is covered by the commentary above.
Ch. 15+250	PBR270	Unidentified bat species	106	3.76	This roost may be abandoned as evidence was limited to small number of old droppings. Bats in this roost to the east of the racecourse are likely to have their CSZ encompassing lands to the east and the west as suggested by the suitable habitats found there. The CSZ is unlikely to stretch to the southwest due to lack of suitable habitats there so even if there is a barrier effect caused by habitat loss there is not likely to be a significant negative effect.

Table 8.32: Extent of direct habitat loss around confirmed bat roosts (day roosts close to the proposed development boundary, but not to be removed) (* takes into account that c.10ha of foraging habitat is being retained intact within the boundary of the proposed road development at Menlough)

Chainage	Roost reference	Species	Area of suitable habitat loss	% of likely core foraging area.	Likely significance of Impact of habitat loss
Ch. 1+600	PBR225	Soprano pipistrelle bats Brown long-eared bats	35ha 44ha	2.79% 1.56%	This roost is a possible maternity roost for Soprano pipistrelle bats and is located close to the footprint of the proposed road development. Whilst screened by a cluster of trees, the buildings will be close to earthworks and site clearance and be adversely affected by these. Surrounding habitats are mostly heath and peatland and whilst open in nature they do support feeding resources as suggested by detector records for this species along the minor roads. The impact of habitat loss is likely to result in a significant negative effect at a local geographic scale during construction due to the barrier effect likely to be posed by the proposed road at this location.
Ch. 4+500	PBR139	Leisler's bat.	100ha	1.99%	This property on the Cappagh Road was used by a tagged Leisler's bat. This species is known to move roost locations frequently and is also less affected by severance of landscape connectivity. It is predicted that there will be little material disturbance to the landscape close to the roost and that the habitat loss is unlikely to affect this small roost.
Ch. 7+400	PBR49	Soprano pipistrelle Brown long-eared bats	64ha 82ha*	5.1% 2.9%	This roost on the Letteragh Road is likely to be supported by the woodland immediately surrounding the buildings and also small clusters of woodland and hedgerows to the southwest at Mincloon. The removal of habitats will include some optimum habitat for both species and will also pose a considerable barrier effect to movements to the north east from the roost due to the proposed N59 Letteragh Junction. Overall the

Chainage	Roost reference	Species	Area of suitable habitat loss	% of likely core foraging area.	Likely significance of Impact of habitat loss
					potential impact is likely to result in a significant negative effect at a local geographic scale.
Ch. 8+150	PBR173	Brown long-eared bats	92ha*	3.25%	This potential maternity roost for this species is located close to the footprint of the proposed road development and it is likely that the removal of habitats will result in loss of foraging and connections to other foraging resources. However, habitats preferred by this species would be the taller dense hedgerows and gardens in The Heath to the south which will remain connected to the current roost location. However, the indirect effects of habitat loss may result in disturbance to the roost on the basis of proximity alone. Such an impact is likely to result in a significant negative effect, at a local geographic scale.
Ch. 0+50 N59 Link Road	PBR73	Natterer's bat	122ha*	2.43%	This roost at St James's Church was recorded by Members of Galway Bat Group. This is only one of three roosts for this species and bat detector records for Myotis species generally are thinly distributed across the study area. The location of the roost is close to a proposed link road in cut which could affect flight paths if bats are present. Significant impacts on this species are unlikely given the absence of any evidence that the roost is occupied. The N59 Moycullen Road is also illuminated at this location and may prevent bats flying eastwards. Suitable habitat for this species are also found to the south and landscape connectivity in this location will not be compromised by the proposed road development.
Ch. 9+375	PBR06	Lesser horseshoe bat	88ha* (based on merged	3.35%	Menlo Castle roost is located at the edge of the proposed development boundary for the proposed road development but is 140m from the likely working area. This distance is unlikely

Chainage	Roost reference	Species	Area of suitable habitat loss	% of likely core foraging area.	Likely significance of Impact of habitat loss
		Daubenton's bats.	radio tracked bats MCPs from 2014 and 2015) 11ha* (based on core foraging area recorded May 2015) 129ha*	8.8% 2.57%	to directly affect the roost during the construction as most Lesser horseshoe bats were noted to fly straight into the adjoining hedgerows and hugged the edge of the castle. The loss of habitats is likely to affect the foraging resources to the highest degree during the pre-partum period (May-June) when female bats tend to hunt close to the roost. Radio-tracking of bats in 2015 in this period notes that the CSZ is bisected by the road corridor with c.45ha left to the southeast and c 70ha to the northwest. There is suitable habitat within 2km of the roost that bats are known to use at other times of year and it is not unreasonable that bats may adapt their CSZ geometry to address changes in the landscape providing there are linkages to do so. Nevertheless, the potential loss of pre-parturition feeding habitat (11ha, of which 8ha is thought to be optimum feeding habitat) and the potential indirect loss of feeding habitats due to a barrier effect (45ha) is likely to result in a significant negative effect at a national geographic scale, as it could threaten the long-term viability of the roost. The potential impact on the Daubenton's roost during construction is not deemed to be significant as bats will be able to reach feeding ground in the river corridor unimpeded and there will be no loss of this habitat type from their CSZ. Other habitats types will be removed but are less likely to be utilised as suggested by radio-tracking data collected for this species.
Ch. 13+000	PBR145	Brown long-eared bats	120ha	4.24%	This roost was used by a post-lactating female which could be a small maternity roost for this species. It was captured at Cooper's Cave and is therefore known to fly in the area south of Castlegar. In the absence of any radio-tracking data to

Chainage	Roost reference	Species	Area of suitable habitat loss	% of likely core foraging area.	Likely significance of Impact of habitat loss
					confirm the location of the CSZ, it is predicted that the loss of habitat to the north of the roost may cause depreciation in the foraging resources available to the colony and lowering of fecundity. It is unlikely that the roost would be abandoned as there is still plenty of foraging habitat available to the south. Therefore, such an impact is likely to result in a significant negative effect at a local geographic scale.
Ch. 13+000	PBR153	Lesser horseshoe bat	100ha	3.54%	This shed/stable was used as a day/night roost by a single tagged bat (No. 12) in 2014. This bat foraged almost exclusively south of this roost between Castlegar and Cooper's Cave and particularly in the network of small fields south of Castlegar. Since there was little evidence of bats using this roost on a continuous basis and little evidence for flights across the proposed road development, the effects on this roost alone is not deemed to be significant. However, if the habitat loss prevents the passage of individuals between the Menlo Castle maternity roost and Cooper's Cave then it may isolate this roost from the core population in Menlough. The impact is likely to result in a significant negative effect at a local geographic scale.
Ch. 13+600	PBR192	Brown long-eared bats	133ha	4.7%	This roost is thought to support a small number of bats of this species as suggested by the droppings but no live bats were noted in 2015 or 2016. The property is close to the edge of the proposed construction area and any linear features connecting bats to the scrub and woodland to the north will be severed. Connectivity to the south toward Castlegar will be maintained and it is predicted that this habitat is sufficient to support this small roost. Nevertheless, the loss of the connectivity to the

Chainage	Roost reference	Species	Area of suitable habitat loss	% of likely core foraging area.	Likely significance of Impact of habitat loss
					north and the potential disturbance caused by habitat loss may cause abandonment of the roost which is likely to result in a significant negative effect at a local geographic scale.
Ch. 13+900	PBR228	Common pipistrelle bats	76ha	6.05%	This small roost of bats (3-4 no.) is predicted to have its CSZ primarily to the north and east, especially the scrub and the quarry close by. There are well distributed detector records for this species throughout the theoretical CSZ. Loss of habitat close to the roost may displace bats from feeding near the construction area but the availability and connectivity to habitat to the north and east will be maintained. The impact is likely to result in a significant negative effect at a local geographic scale if the roost is used less frequently or abandoned altogether, although the latter is not predicted since the building is well screened from the construction area by trees and scrub.
Ch. 14+450	PBR242	Unidentified pipistrelle bats	82ha	6.53%	The small numbers of bats thought to use this roost near the Galway Racecourse are likely to have their CSZ encompassing lands to the east and the west as suggested by the suitable habitats found there. The CSZ is unlikely to stretch to the southwest due to lack of suitable habitats. However, there may be a barrier effect caused by habitat loss preventing bats reaching lands to the north and east of the road during the construction phase although this will be temporary and likely to be reversed once the Galway Racecourse (ST14/02) tunnel is covered. The impact is likely to result in a significant negative effect at a local geographic scale for this roost.

Chainage	Roost reference	Species	Area of suitable habitat loss	% of likely core foraging area.	Likely significance of Impact of habitat loss
Ch. 13+100	PBR112	Lesser Horseshoe bats	124ha	4.39%	Cooper’s Cave. Passage between here and Menlo Castle is likely to be significantly affected by the barrier effects posed by the loss of connecting features during construction of the proposed road development. This potential impact is likely to result in a significant negative effect at a national geographic scale due the level of importance that the cave plays in the life cycle of the bat population in this area.

The proportion of habitat loss relating to each roost being lost is less than 7% of the CSZ in all cases except for PBR225 (stable block at Galway Racecourse) and less than 5% of the CSZ in the majority of cases. In the case of PBR225 the majority of the "real" CSZ is likely to extend to the quarry to the north west and agricultural land as foraging opportunities are more limited in the urban landscapes to the south. Much of the "real" CSZ is not affected by the proposed road development.

For Pipistrelle bat species which are adapted to feeding in a wide variety of landscape types[65], the impact of habitat loss during construction is not predicted to be significant since these bats will be able to utilise the majority of suitable habitat in their CSZ that is currently available to them and are not reliant on having to cross the construction area to reach foraging areas. This applies particularly to roosts to the north of the proposed road development as the majority of optimal feeding areas are outside of the urban city core which lies to the south.

For Lesser horseshoe bats which show a greater preference for following linear landscape features between roosts and foraging areas[66], the potential impact of habitat loss is compounded by the barrier effect which may prevent bats using suitable habitats on the other side of the proposed road development or moving between day and night roosts or between different roosts used at other times of year. Impacts are regarded to be potentially significant at a county level if the foraging range is affected (e.g. by not being able to reach night roosts) or national-scale where the fecundity or mortality rates are affected due to lack of feeding resources as a result of loss of feeding habitat and barrier effects. Significant efforts have been made to provide effective methods to getting bats across the construction areas and underneath or over the proposed road development so that they can avail of habitats on both sides of the proposed road development.

The magnitude of habitat loss for Lesser horseshoe bats has been measured in terms of the physical loss of the most important habitat as a result of the proposed road development. The area deemed to be of highest importance for Lesser horseshoe bats is regarded to be the core foraging area used by Menlo Castle (PBR06) radio-tracked bats in summer 2015. Prior to the birthing period in mid-June, female bats will utilise the best foraging habitats closest to the roost and research in at least one study (Bontadina et al, 2002[67]) has highlighted the importance of habitat within 600m of the roost. Whilst 11ha of habitat will be lost (which equates to nearly 9% of the core foraging area estimated after radio-tracking in 2015) only 7ha is regarded to be optimum feeding habitats for this species. This area of woodland, scrub, hedgerows and grassland will be lost in the area from the River Corrib to the Bothár Nua which spans the core foraging area for the Menlo Castle roost (PBR06).

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[65] In the CEDR guidelines they are in Group C: Bats with medium manoeuvrability. They often hunt and commute along vegetation or structures at variable heights, but rarely close to or within the vegetation. May also hunt in open areas. Commuting over open stretches generally takes place at low to medium heights (typically 2 – 10m) with no clear tendency to lower flight.

[66] In the CEDR guidelines they are in Group A: Extremely manoeuvrable bats, which often fly within foliage, or close to vegetation, surfaces and structures at variable flight heights. When commuting, they often follow linear and longitudinal landscape elements. Low-flying (typically < 2m) when commuting over open gaps.

[67] Bontadina, F., Schofield H. and Naef-Daenzer B. (2002) *Radio-tracking reveals that Lesser horseshoe bats (Rhinolophus hipposideros) forage in woodland*. J. Zool., Lond. 258, 281-290.

The loss of this 7ha equates to 5.6% of the core foraging area (125ha) recorded in 2015 which is regarded to be the area of highest importance for the roost[68], although not all of the core foraging area is used equally by bats. The loss of habitat within the core foraging area for the Menlo Castle Lesser horseshoe roost (PBR06) is deemed to be a potentially significant factor threatening the viability of the roost there. If bats cannot feed close to the roost, especially close to the birthing period, then fecundity may be reduced. When compounded by other potential effects of the proposed road development (collision, barrier effects) this relatively small loss of habitat might have a significant effect on the population.

Other bat roosts in proximity along the proposed road development are unlikely to be associated with such optimum bat habitats. The loss of woodland in the Menlough area is unavoidable as the belt of woody vegetation on the northeast bank of the river stretches from the Quincentenary Bridge in the city all the way to Menlough Village and therefore the proposed road development will inevitably cross it at some location.

In order to prevent the loss of foraging habitats resulting in an adverse impact on bat species at either a local, county or national geographic scale, design measures have been incorporated into the design of the proposed road development.

The tables above (**Table 8.31** and **Table 8.32**), documents the impact predictions relating to each individual roost site that will either be removed as part of the construction phase or are close enough to the working footprint so as to warrant concern. There are other roosts further away from the proposed road development that have their CSZs that overlap with the proposed road development and could be adversely affected by the loss of foraging habitats. The impacts on a broader geographic scale are discussed below.

Fragmentation of foraging habitat and commuting routes and areas used by bats for other non-roosting activities[69]

Given that there is evidence of bats crossing the proposed road development in multiple locations, and that all parts of the proposed road development are within the theoretical or proven CSZ of at least one bat roost, there is the potential for the proposed road development to act as a barrier to flight paths for all species (except Leisler's bats which have been shown to fly at greater altitudes so as not to be affected by ground level features) and in all locations.

The barrier effect can manifest itself as soon as the site clearance phase commences and the barrier itself is in the form of the cleared lands. Removal of hedgerows, treelines, woodland and scrub will take place across the length of the proposed road development. Whilst it is not proposed to remove all the vegetation within the proposed development boundary, it has been assumed that intervention of some kind in the landscape may occur within the boundary to the extent that it could affect bat behaviour, thereby assessing the worst-case scenario.

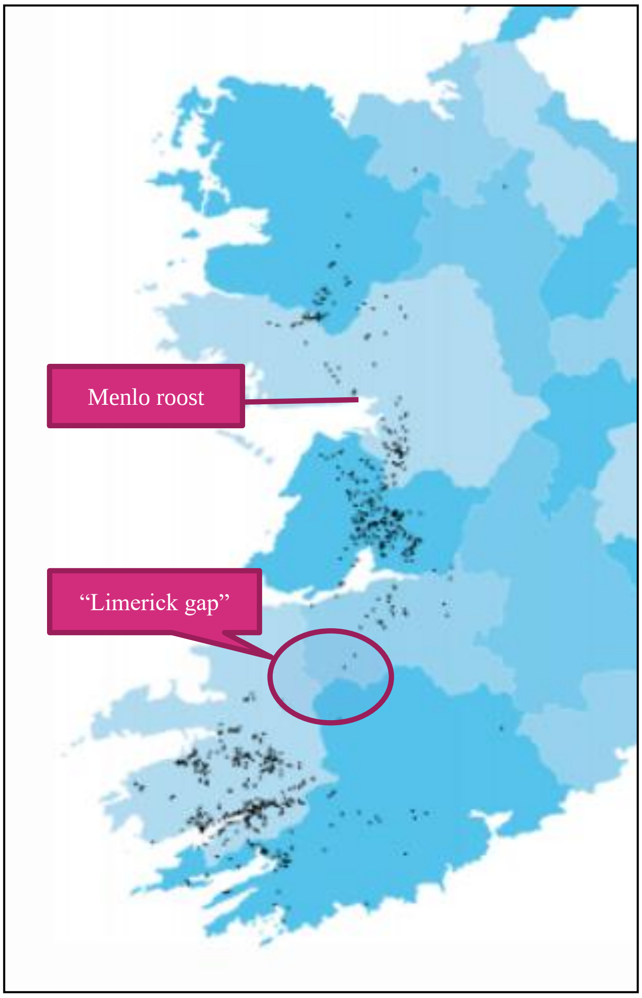
[68] This differs from the 98ha of land within the proposed development boundary which is within the 2925ha of CSZ for the roost at Menlo Castle, based on the MCPs for bats tracked in 2014 and 2015.
[69] As fragmentation of feeding habitat has the potential to disturb normal bat behavioural patterns, and thus adversely affect the ability of local bat populations to persist and reproduce, impacting on their local distribution and/or abundance and thereby conflicting with Regulation 51(b) of S.I. 477.

Interpretation of the patterns of bat activity records has indicated that potential barrier effects would be most significant at the following locations:

1. Bats flying to/from Bearna Woods – The woods were one of the few sites where Natterer's bats were recorded and also support a small/dispersed population of Lesser horseshoe bats. The relatively open, heathy landscape to the north of the woods would be regarded to offer less suitable opportunities for bat foraging so the woods are likely to be important for local populations of several bat species.
2. Aughnacurra (including Chestnut Lane and Upper Dangan) – the potential barrier effect posed by the proposed road development here is somewhat reduced by the proximity of the River Corrib which bats use as a flight corridor. The barrier effect would be likely to supress movements at a very localised scale.
3. Barrier effects in the area spanned by Menlough Castle-Coolagh-Castlegar are potentially the most significant as it is the known core foraging area/CSZ for the nationally-important Menlo Castle population of Lesser horseshoe bats as well as for roosts of other bat species close to the proposed development boundary. Severance of Lesser horseshoe flight paths between Menlo Castle and Cooper's Cave in particular could have significant effects on the ability of the breeding population to mate and hibernate in suitable roosts. Severance of flight paths between day and night roosts also could affect the ability of bats to reach suitable foraging areas further away by using the night roosts as stepping-stones.
4. The location of the Menlo Castle roost is regarded to be at a key location in the national distribution of Lesser horseshoe bats. The main strongholds for this species are in south Mayo, mid-Clare/south Galway, Kerry and West Cork but the species is present all along the west coast counties from Cork to Leitrim. Analysis of the genetic and echolocation differences has revealed that the Irish population is made up of differentiated north and south populations (Dool et al, 2016[70]). Factors such as habitat connectivity were identified as being one of the reasons why this species is subject to population fragmentation at a national scale. Dool et al (2016) describe the "Limerick gap" as an area where there has been a separation of lesser horseshoe bat populations, leading to genetic isolation in these areas. As can be seen in **Plate 8.2**, the Menlo Castle roost is in an area of similarly low densities of roost records and the loss of the population could create a new gap in in the natural range of the species in Ireland.

[70] Dool S.E., Puechmaille S.J., Kelleher C., McAney K., and Teeling E. (2016) *The effects of human-mediated habitat fragmentation on a sedentary woodland-associated species (Rhinolophus hipposideros) at its range margin.* Acta Chiropterologica, 18(2): 377–393, 2016.

Plate 8.2: Lesser horseshoe bat population distribution (taken from Bat Conservation Ireland distribution maps)



5. Based on the distribution of maternity roosts in the range of this species in Ireland, the Menlo Castle maternity roost and the local population it supports are of national importance, as defined in NRA (2009) “a smaller population may qualify as nationally-important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle”. However, the roost size falls well below the threshold for designation as a Special Area of Conservation (100 bats in maternity roost) and it has been confirmed by the NPWS as not being part of the Lough Corrib cSAC’s qualifying interest population.

6. There are only six known maternity roosts in and around Lough Corrib, with the majority of roosts concentrated on the northern shores near Cong. Only two roosts are located on the southern end: Ross Lake Gatehouse and Menlo Castle. These southern roosts may be stepping-stones for long-term movements and gene flow between bats at the northern shore of Lough Corrib, Lough Mask and Lough Carra and populations in South Galway and Clare. Recent counts from Ross Lake Gatehouse have shown that this roost has undergone significant deterioration resulting in decline in numbers from 150 bats in 1994 to five bats in 2011 (Rebecca Teesdale pers. Comm., 2014 and p44 in Roche et al, (2015)). A decline in the Ross Lake roost could potentially

increase the relative importance of the roost at Menlo Castle as a stepping stone roost, as it would be the only significant maternity colony at the southern end of Lough Corrib. Menlo Castle itself would not appear to be in a structurally-stable condition and the bat roost is vulnerable to rock fall, vandalism and blockage within the chimney flue. If bats were not able to reach the foraging areas and Cooper's Cave due to a barrier effect, then it would add another impact which might put the viability of this population at risk. Such impacts have the potential to result in a significant negative effect at the national geographic scale for the Lesser horseshoe bat. There is no evidence to suggest that Menlo Castle Lesser horseshoe bat population is connected to the Eborhall Lesser horseshoe bat population, which is the qualifying interest (QI) population for Lough Corrib cSAC. Any predicted impacts on Lesser horseshoe bats associated with the proposed road development will not affect the conservation objectives of the Lough Corrib cSACs QI Lesser horseshoe bat population, nor the QI Lesser horseshoe bat populations of any other European sites.

The numbers of Lesser horseshoe bats recorded using Cooper's Cave for hibernation has been relatively small (around 10% of the estimated roost size at Menlo Castle) but much of the cave is not accessible and there may be higher numbers present. The only other hibernation site known for this population is Menlo Castle and the roost site is not accessible for counting. A wildlife overpass has been included as part of the design of the proposed road development to allow bats to reach the cave for hibernation and to avoid them being forced to use less suitable locations. While Cooper's Cave is under ongoing pressures from fly tipping and disturbance, it is likely that bats will continue to use it unless the entrance is blocked altogether.

The western portion of the proposed road development (from Bearna to Upper Dangan) has a lower distribution density of bats and has less-suitable habitats for foraging but a barrier effect is still predicted in the absence of any effective mitigation. Such potential impacts are likely to result in a significant negative effect at a local geographic scale as the bat populations have been valued as being important at a local geographic scale, there are few roosts known in this area, and no important landscape features (such as major watercourses, areas of woodland or hedgerow networks) are predicted to be severed.

Mitigation to preserve flight paths across construction areas are detailed in **Section 8.6.7.2.1**.

Installation of temporary working and site compound lighting which may cause indirect disturbance of flight patterns

As construction works will typically be undertaken during normal daylight working hours, the requirement for lighting for construction works during night time will be limited.

Over the expected 36-month construction phase there will be up to a total of 10 weeks of night time working. Temporary night-time closure of existing local roads may be required where overbridges are to be constructed at locations such as the Rahoon Road, Letteragh Road, N59 Moycullen Road, Menlo Castle Bóithrín, Bóthar Nua, Seanbóthar, N84 Headford Road, N83 Tuam Road, Briarhill Business Park Road and R339 Monivea Road.

Night-time working requiring the use of floodlighting to permit safe working have the potential to displace bats from the illuminated area. This will be particularly sensitive at the following locations:

- N59 Moycullen Road near the Aughnacurra satellite roost (PBR178) and a proposed replacement roost structure
- Menlo Castle Bóithrín which is an important flight path for Lesser horseshoe bats and other bat species
- Bóthar Nua which is an important flight path for Lesser horseshoe bats and other bat species
- Seanbóthar which is an important flight path for Lesser horseshoe bats and other bat species
- N84 Headford Road which is an important crossing point for Lesser horseshoe bats and close to known night/occasional day roosts for this species and is also close to a proposed replacement roost structure

In all cases where lighting may cause disturbance, it will be temporary in nature but may last over several consecutive nights and this could result in temporarily lower bat diversity in these areas. Such displacement (which would be a matter of metres) could prevent bats from accessing foraging areas or roosts, or result in bats taking more circuitous routes to get to foraging areas and hence potentially depleting energy reserves. It cannot be predicted precisely when these works will take place during the year but it could be a significant disturbance if affecting bats pre-parturition (birth) or pre-hibernation when energy reserves are essential for survival. However, the potential impact only arises during months when bats are most active (April to September) and during these months the need for night lighting is likely to be limited as daylight hours are longer. Such potential impacts have the potential to result in a significant negative effect at a local geographic scale.

8.5.6.2.2 Operational Phase Impacts

Direct mortality through collisions

Research (Butchkowski and Hassinger, 2002; Dodd et al., 2004; Capo et al., 2006; Choquene, 2006; Glista and DeVault, 2008; Hein et al.,2009; Russell et al., 2009; Sparks and Choate, 2000; Whitaker and Mumford, 2009) has provided evidence that mortality of bats due to road collisions can reach an annual mortality of 5% of the bats in local roosts. Altringham (2008) arrived at a similar estimate, based on conservative calculations for a road in the UK crossed by lesser horseshoe bats from a large roost (data from Billington, 2001-2006).

Theoretical studies (e.g. Lande 1987, With and King 1999, Carr and Fahrig 2001) *"*show that populations of animal species with low reproductive rates and high intrinsic mobility, such as bats, are more susceptible to decline and ultimately extinction by the additional mortality caused by roads" (taken from Appendix A, WC1060 main report).

Lesiński (2007) recorded mortality highest where roads approached tree stands (up to 6.8 per km/year) or crossed a forest (2.7 per km/year) and lowest within densely built-up areas (0.3 ind./km/year). If the highest rates were applied to the Lesser horseshoe bat roost at Menlo Castle (PBR06) then this could equate to 34 deaths per year based on the maximum roost foraging area being bisected by c. 5km of the proposed road development (based on radio-tracking in 2014). The lower rate for mortality near forests would result in 13 deaths per year. Whilst the long-term population fluctuations are not known for this population, in a worst-case scenario such mortality rates could cause the entire roost to become extinct in less than two years assuming that all of the bats in the roost are exposed to the same level of mortality risk and that all of the bats killed per km were of this species. The loss of this roost would be regarded to be a significant potential effect at a national geographic scale, assuming a worst-case scenario and in the absence of any mitigation.

Similar mortality rates could be applied to similar low-flying gleaning species of bats such as Brown long-eared bats and some *Myotis* species such as Daubenton's bats. Since this would have significant negative effect on these species, a complex mitigation strategy has been developed and is presented in **Section 8.6.7.2.2**.

Barrier/Severance effects

The effects of the proposed road development on the movements of bats across the landscape after completion have been studied more frequently than the effects during the construction phase. Monitoring of bat activity around road schemes have shown the effects of traffic disturbance, lighting, loss of connecting landscape features and foraging habitats can result in depreciation in bat activity up to 1.6km from the road itself in certain landscapes (Berthinussen and Altringham (2012b, 2015), Elmeros et al (2016). The research is still in progress and the effects of different habitat types at the edge of the road carriageway is yet to be fully understood. In the absence of fully applicable research, it is predicted that potential significant impacts caused by the proposed road development acting as a barrier to landscape-scale movements may occur in the following location and on the following species:

- Movements of bats to Bearna Woods: As described in the context of impacts on PBR241, the proposed road development may impact on the movements of bats using north-south trajectory. Bearna Woods was noted as an area of relatively high bat diversity and abundance and is one of the few areas of continuous woodland in this part of the study area. A barrier effect may limit populations mixing outside of the Bearna Woods area and potentially lead to decline in reproductive rates. There are seven confirmed roosts south of the proposed road development near Bearna which could persist in the presence of the proposed road development but will have more limited access to foraging areas north of the proposed road development. The survey results have suggested widespread bat activity along the roads aligned north-south. Some of these may continue to be used by bats and cross the narrower parts of the mainline of the proposed road development but there are no junctions in this location that allow bats to pass under the proposed road development

- Movements of bats along banks of the River Corrib: Currently, bats move up and down the River Corrib corridor unhindered by lighting or physical obstacles. It is possible that existing lighting within the NUIG campus and at Quincentenary Bridge may be a deterrent to light-sensitive bats such as Lesser horseshoe bats. The proposed road development will introduce embankments for the bridge on both banks which could present a physical barrier to such movements. While bats will be able to fly around the toe of the abutments on each bank and under the elevated deck of the proposed River Corrib Bridge and have free movement over the river itself, such re-routing of flight paths could add to the energy requirements for individual bats. On the west bank, assuming that bats are commuting north-south in the area from the N59 Moycullen Road to the river (750m wide corridor), the proposed abutments would reduce the flight corridor to 420m and lead to an additional c. 500m of flight to get around the abutment in the Aughnacurra area. Assuming a flight speed of 3.5m/s (Lesser horseshoe bat) this would mean that a flight of 60m across the proposed road development that would normally take 17s will take 142s when the proposed River Corrib Bridge is in place. On the eastern bank, bats will be able to fly either around the western toe of the bridge abutment or under the road at the Menlo Castle Bóithrín with the barrier stretching between the two points for a distance of 210m
- Movement of bats in the area around Menlough-Coolough Road-Ballindooley-Castlegar area: this area is regarded to be important for Lesser Horseshoe bats, Brown long-eared and Pipistrelle bats. The movement of Lesser horseshoe bats has been confirmed by radio-tracking individuals in 2014 and 2015. This data suggests that the majority of flights across the proposed road development are in the section Ch. 9+500 – Ch. 10+150 between the River Corrib and the Coolough Road. The embankment section will either provide a barrier to bats or force them up and over the proposed road development bringing them across the flow of traffic and risking collision with vehicles. Similar potential barrier effects are predicted at the N84 Headford Road and further east at Ch. 12+200 – Ch. 12+450 and at locations north of Castlegar Village. Static detectors placed at Ch. 12+600 and Ch. 12+750 in 2015 recorded relatively high levels of activity for Lesser horseshoe bats, Common and Soprano pipistrelle bats and Leisler’s bats suggesting that they would be affected by a barrier to movement in this location (Leisler’s bats less so due to their tendency to fly at height).

Barrier effects in the absence of mitigation are likely to result in a significant negative effect at a local geographic scale for all chainages along the route of the proposed road development and at a national geographic scale for effects in the section Ch. 8+500 (N59 Moycullen Road) to Ch. 13+150 (School Road, Castlegar).

Mitigation to reduce barrier effects within the design and operation of the proposed road development are detailed in **Section 8.6.7.2.2**.

Indirect disturbance of flight patterns due to operational lighting

The barrier effect can be compounded by light spill associated with the illumination of the corridor of the proposed road development. Examination of light spill modelling has identified potential light spill impacts on bats (where light levels exceed 1 lux) at the following locations:

- Ch. 2+850: Lighting at the Bearna East Roundabout may impact on the movement of bats in the locality and prevent them using the proposed culvert CO2/01b. However, proposed landscape planting near the mouth of the culvert entrances will help in shading the flight paths approaching the culvert at this location to allow bats to fly through
- Ch. 4+300 - Ch. 4+550: Lighting at the Cappagh Road junction is close to PBR139 and PBR146 (both Leisler's bat roosts) and Soprano pipistrelle activity has been recorded nearby. Localised displacement may occur in this area although the presence of roadside scrub and garden shrubs and trees will provide shaded area which may be used by bats to avoid lit areas
- N59 Link Road North and South: This will be illuminated over a length of 2.4km across open agricultural and heath landscape. Light spill may cause a localised barrier to movements in an east-west direction although there are only two roosts (PBR49 and PBR237) which are parallel to this link road and neither are in the light spill of the proposed lighting design
- Ch. 9+150 – Ch. 9+250: Lighting will be provided as part of the proposed NUIG Sports Pitches. Whilst there is planning permission to floodlight the existing pitches adjacent to the river, they are currently unlit. There are a number of roosts in this general area (for Lesser horseshoe bat, Daubenton's bat, Soprano pipistrelle bat and Brown long-eared bats) however none of them are located within the area of light spill from the proposed lighting. The closest roost is Menlo Castle PRB06 which is approximately 375m from the proposed sports pitches at their closest point. No roosts will be directly impacted. The light spill will not impede bats from using the River Corrib for feeding or commuting. There may be a displacement effect locally from the sports pitches themselves and for an area around the sports pitches due to light spill, however the bat survey results did not record significant levels of usage of these fields by any species.
- Ch. 11+050 – Ch. 11+150: Lighting at western entrance to Lackagh Tunnel. This will be localised and will not affect roosts but is likely to have a displacement effect on bats over an area of circa 150m x 50m where light levels exceed 1 lux. Whilst there is little bat activity data collected for this location, it is likely to be used by several species of bats for feeding and commuting
- Ch. 11+380 – Ch. 11+500: Lighting at eastern entrance to Lackagh Tunnel. This will be localised and will not affect roosts but is likely to have a displacement effect on bats over an area of circa 150m x 50m where light levels exceed 1 lux. There is bat activity data collected for this location including feeding and resting Lesser horseshoe bats and it is likely to be used by several other species of bats for feeding and commuting

- Ch. 11+975 – Ch. 14+500: The N84 Headford Road at this location is currently unlit and the proposed new lighting will introduce approximately 8ha of illuminated area. This area is used by several species including Lesser horseshoe bats and will result in a displacement from this area. PBR154 (a Lesser horseshoe bat night roost and occasional day roost) will be impacted upon by light spill to the roost. However, the entry to the roost will still remain unlit and well shielded from the lighting as it faces to the east and is at a lower elevation than the N84 Headford Road and the proposed road development. Light spill from lighting columns in the area of Ballindooley-Castlegar (Ch. 12+600 to Ch. 13+600) will generally be contained within the immediate vicinity of the proposed road development which, at this location, is sunken below the level of the surrounding landscape. Light spill here will help to deter bats from crossing the road and reduce the risk of vehicle collision, whilst the Castlegar Wildlife Overpass will be in darkness and provide a safe crossing point.
- Lighting in the area around the N83 Tuam Road Junction, the City North Business Park Link and the Parkmore Link Road will alter and may have localised impacts on the flight paths of Pipistrelle species recorded nearby
- Ch. 14+850 – Ch. 15+000: Eastern end of Galway Racecourse Tunnel entrance. This will be localised and will not affect roosts but is likely to have a displacement effect on bats over an area of circa 150m x 50m where light levels exceed 1 lux. This may lead to localised impacts on the flight paths of Pipistrelle species recorded nearby
- Ch. 15+150 – Ch. 15+300: Western end of Galway Racecourse Tunnel entrance. This will be localised and will not affect roosts but is likely to have a displacement effect on bats over an area of circa 150m x 50m where light levels exceed 1 lux. This may lead to localised impacts on the flight paths of Pipistrelle species recorded nearby
- Ch. 15+500 – Ch. 17+483 (end of proposed road development): Scattered records of Pipistrelle species and Leisler’s bats in this location suggest that the widened illuminated corridor in this location will result in localised displacement. This impact is not regarded to be significant as most of the bat records suggest activity is focused to the north east away from the proposed road development

The potential impact of vehicle lighting has been assessed in the context of the potential illumination of Menlo Castle (PBR06). This would have particularly high sensitivity due to the absence of any notable lighting at present and the presence of both a maternity roost and hibernacula for Lesser horseshoe bats, a maternity roost for Daubenton’s bat and a former Brown long-eared roost; all species which would be susceptible to lighting impacts. In a worst case scenario, the cumulative impact of many vehicles on the River Corrib Bridge on Menlo Castle is less than 0.01 lux and this would only result on the top section of the castle. Given that the Lesser horseshoe bats generally flew at heights of 1-3m above the ground at and near the roost location this is not predicted to affect their flight paths. This level of illumination is also well within the tolerance range for this species.[71].

There are no roosts that will be directly illuminated by the proposed operational lighting to the extent that any likely significant effects are predicted.

8.5.6.3 Badger

8.5.6.3.1 Construction Phase Impacts

There were a total of 17 badger setts recorded across the study area. Three of these setts (S9, S11 and S14) were within the proposed development boundary. Two setts (S3 and S10) were within the ZoI of general construction activities (i.e. within 50m) based upon the impact distance bands described in the TII guidance (National Roads Authority, 2006c). A further seven setts (S2, S4, S8, S13, S15, S16 and S17) were within the ZoI of any potential pile driving or blasting works—i.e. within 150m. The remaining setts (S1, S5, S6, S7 and S12) are beyond the ZoI of any construction activities.

Although it cannot be predicted if Badger will establish new setts within the ZoI of the proposed road development before construction works commence, it is a possibility and this scenario has been taken into account in the mitigation strategy (refer to **Section 8.6.7.3**).

Based on interpretation of the survey results, the directly affected badger setts (S9, S11 and S14) were considered to be within the territories of two badger groups. S9 and S11 are considered to be part of one badger group to the east of Lackagh Quarry (hereafter, referred to as the Lackagh badger group). S14 is considered to be part of a separate badger group west of the N83 Tuam Road Junction at Cappanabornia (hereafter, referred to as the Cappanabornia badger group).

Loss of Foraging Habitat

Construction will result in the permanent loss of foraging habitat within the territories of up to ten badger groups across the study area[72]. The loss of habitat is likely to affect each of the badger groups to some degree, at least temporarily, as it will reduce the foraging area and feeding resource available within their existing territories. This is also likely to have a knock-on consequence of increased conflict with neighbouring Badger groups in competition for resources - although this territorial behaviour is a natural dynamic between neighbouring Badger groups in response to many other factors that affect population numbers, territorial behaviour, and dispersion of individuals.

[71] Average light levels recorded along preferred commuting routes of *Rhinolophus hipposideros* under natural unlit conditions were 0.04 lux across eight sites. Stone E.L. (2011) *Bats and development: with a particular focus on the impacts of artificial lighting.* (Ph.D. Thesis) University of Bristol, UK (2011).

[72] This territory number estimate is based upon an interpretation of the survey results – sett locations, sett types, and the distribution of signs such as tracks, foraging and latrine sites

There is an abundance of alternative suitable foraging habitat locally which is likely to be sufficient to maintain the local population in the long-term. Although the actual effect of foraging habitat loss cannot be quantified in terms of any threshold value that could be predicted, each of the affected Badger groups would be expected to adapt to the changed landscape. It is therefore predicted that, despite any temporary effects, the loss of foraging habitat associated with the proposed road development is unlikely to affect the conservation status of the local badger population and will not result in a likely significant negative effect, at any geographic scale.

Loss of breeding/resting sites

The proposed road development will result in the permanent loss of three badger setts, affecting two badger groups: the main sett (S9) and a subsidiary sett (S11) of the Lackagh Quarry badger group; and, a subsidiary sett (S14) of the Cappanabornia Badger group.

The significance of sett loss in relation to any badger group is based upon consideration of the type of sett, its importance to the badger group, and the availability of either alternative setts for affected badgers to relocate to or the availability of alternative suitable sett building habitat within the territory. Locally, given the underlying karst nature of the area, limestone is generally overlain by thin soils and frequently outcrops locally as limestone pavement; offering limited opportunities for sett building habitat. As a consequence, the significance of sett loss with respect to both badger groups is largely dependent on the presence of existing alternative setts within their territories. As discussed above in relation to loss of foraging habitat, sett loss may also lead to increased conflict with neighbouring Badger groups if alternatives, in the form of existing setts or suitable habitat to construct setts, are not available within the existing territory. There is also the potential for Badgers to be killed during site clearance works where setts are being removed.

The Lackagh Quarry badger group will lose two out of three setts (S9 and S11) recorded within their territory — including the main sett. The remaining subsidiary sett (S10) lies within the ZoI of what will likely be significant disturbance effects resulting from rock breaking and blasting associated with excavating the eastern approach to Lackagh Quarry, from the N59 Moycullen Road. Considering those factors and that there is little alternative suitable sett building habitat in the immediate vicinity, the proposed road development may have a long-term effect on this Badger group. On that basis, it is considered that the proposed road development has the potential to negatively affect the conservation status of this badger group and result in a likely significant negative effect, at a local geographic scale.

In relation to the Cappanabornia badger group, the proposed road development will result in the loss of a single subsidiary sett (S14) within its territory. There are two other Badger setts nearby, S13 and S15, both of which were also classified as subsidiary setts. Whilst it is not known whether all three setts are used by the same Badger group, based on their relative locations and distance from one another, it's probable that at least one of those setts is and would therefore provide a suitable alternative to S14. Given there are alternative setts, and alternative suitable sett building habitat, available beyond the ZoI of general construction activities the loss of sett S14 is not likely to affect the species ability to maintain itself on a long-term basis locally, will not affect its conservation status locally, and will not result in a likely significant negative effect, at any geographic scale.

Given the legal protection afforded to Badgers under the Wildlife Acts, which prohibits their intentional killing or injury, or the wilful interference with their breeding or resting places, a mitigation strategy has been developed (see **Section 8.6.7.3.1**).

Disturbance/displacement

In conjunction with any displacement effects associated with habitat loss, increased human presence and/or noise and vibration associated with construction works, has the potential to displace badgers from both breeding/resting places and from foraging habitat. As construction works will typically be undertaken during normal daylight working hours and badgers are nocturnal in habit, displacement of badgers from foraging areas (outside of areas where foraging habitat will be lost as a result of the proposed road development) is extremely unlikely to affect the local badger population and will not result in a likely significant negative effect, at any geographic scale.

Two badger setts (S3 and S10) outside the proposed development boundary were within 50m of construction works and therefore, likely to be subject to temporary disturbance/displacement effects. Any disturbance/displacement impact is likely to be more significant during the badger breeding season (December to June inclusive) if the sett is in use at that time. A further seven setts were located within 150m of the proposed development boundary and therefore, likely to be subject to temporary disturbance/displacement construction effects associated with any rock breaking, blasting or pile driving works that may be required. If undertaken during the breeding season, this could result in the displacement of badgers from occupied setts, potentially affecting breeding success.

On a precautionary basis, disturbance/displacement effects during construction have the potential to negatively affect the conservation status of local badger groups/populations (at least in the short-term) and could result in a likely significant negative effect, at a local geographic scale.

Given the legal protection afforded to Badgers under the Wildlife Acts, which prohibits their intentional killing or injury, or the wilful interference with their breeding or resting places, a mitigation strategy has been developed (see **Section 8.6.7.3.1**).

Severance/barrier effect

It is considered near-certain that the physical disturbance to the existing landscape during site-clearance and construction will result in some initial temporary severance of Badger territories through which the proposed road development traverses; most notable where it severs the network of setts within a given territory (as is the case with the Cappanabornia Badger group), or setts from foraging areas (as in the case of the Lackagh Badger groups).

However, given that Badgers are nocturnal in habitat and works will be carried out during normal daylight working hours, affected Badger groups would be expected to habituate to the altered landscape. The severance/barrier effect of construction works will be temporary in nature and is not likely to affect the local population, over even the short-term, and will not result in a likely significant negative effect, at any geographic scale.

8.5.6.3.2 Operational Phase Impacts

Habitat Severance/Barrier Effect

The presence of a new road along the offline sections of the proposed road development, where it severs existing Badger territories, has the potential to act as a permanent barrier to Badger movements: either acting as a physical barrier or through traffic deterring Badgers from attempting to cross.

However, some sections of the proposed road development will be either elevated above ground level on piers or will pass through a subterranean tunnel (e.g. the proposed River Corrib Bridge, Menlough Viaduct and the proposed Lackagh Tunnel). In these locations, an accessible link will be maintained across the proposed road development either beneath viaduct/bridge structures or above tunnels, which will serve to maintain habitat connectivity within each affected Badger territory (Eldridge & Wynn, 2011).

Nevertheless, there will be extensive lengths of the proposed road development that may act as a barrier to Badger movements within the study area. This has the potential to have a long-term impact on local Badger population dynamics, affecting both local foraging behaviour and competition for resources and larger scale movements associated with dispersal and/or with breeding behaviour and genetic exchange between populations.

The habitat severance/barrier effect to Badgers associated with the proposed road development has the potential to affect local Badger populations over the long-term and result in a likely significant negative effect, at a local geographic scale. Mitigation measures have been designed to reduce the effects of this impact (**see Section 8.6.7.3.2**).

Mortality Risk

The introduction of the proposed road development into a rural landscape will permanently increase the risk of road traffic collisions with Badger, across the study area. The risk is likely to be higher in areas where the proposed road development is in close proximity to Badger setts, is severing Badger territories, or is passing through habitats where high levels of Badger activity were recorded (see **Figures 8.3.1** to **8.3.14**).

Although it is not possible to quantify the magnitude of the effect, the increased collision risk would likely result in a long-term suppression of the local Badger population in these areas and would negatively affect the conservation status of the local Badger population.

Collision risk to Badgers associated with the proposed road development is predicted to result in a likely significant negative effect, at a local geographic scale. Mitigation measures have been designed to avoid this potential impact (see **Section 8.6.7.3.2**).

Light Spill

Nocturnal mammals, such as the badger, are likely to be disturbed by the introduction of artificial light into established breeding and foraging areas (Rich & Longcore, 2005). Along the proposed road development lighting is proposed only at the Bearna West Roundabout, the Bearna East Roundabout, the Cappagh Road Junction, the Ballymoneen Road Junction, the N59 Link Road North and South, the western and eastern portals to the Lackagh Tunnel, the proposed NUIG Sports Pitches, the N84 Headford Road Junction to the N83 Tuam Road Junction including the junctions at the Galway Racecourse Tunnel and the Coolagh Junction. The majority of the proposed road development will remain unlit, minimising the potential for light spill to affect fauna species. The lighting design of the proposed road development controls light emissions such that along the majority of the alignment light spill does not extend beyond the proposed development boundary and where it does, this is at tie-ins with the existing road network or at residential properties (**Figures 5.4.01** to **5.4.14**). There are no badger setts, or areas of high badger activity, beyond the proposed development boundary that are located within the modelled light spill zone for the proposed road development.

Therefore, lighting associated with the proposed road development will not disturb or displace Badgers from habitat areas beyond the proposed development boundary, will not affect the species conservation status in that regard and will not result in a likely significant negative effect, at any geographic scale.

8.5.6.4 Other Mammal Species

8.5.6.4.1 Construction Phase Impacts

Habitat Loss

Road construction will result in the permanent loss of mammal habitat within the boundary of the proposed road development. Given the relatively low numbers of individuals of each species that are likely to be affected (Pine marten, Wood mouse, Red squirrel, Irish stoat, Hedgehog, Pygmy shrew, Fox, Rabbit, Mink and Bank vole), and the abundance of alternative suitable habitat available locally, the effects of habitat loss associated with construction works are unlikely to affect the long-term viability of their local populations. Therefore, habitat loss is unlikely to affect the species' conservation status or result in a significant negative effect, at any geographic scale.

Mortality Risk

Site clearance works have the potential to result in the mortality of mammal species. The potential for impact would be expected to be greater during the breeding season when juveniles would be present in nests, or in the case of Hedgehog impacts may be greater during their hibernation period. Given the relatively low numbers of individuals of each species that are likely to be affected, and that they are highly mobile species, site clearance is unlikely to result in a level of mortality that would affect the species' conservation status, and result in a significant negative effect, even at a local geographic scale.

Habitat Severance/Barrier Effect

As discussed above in relation to Badgers, the presence of a new road along the offline sections of the proposed road development has the potential to act as a permanent barrier to many other terrestrial mammal species. Either acting as a physical barrier or through traffic deterring mammals from attempting to cross.

Sections of the proposed road development elevated on piers and above tunnels will serve to maintain habitat connectivity. Nevertheless, there will be extensive lengths of the proposed road development that may act as a barrier to the movements of other terrestrial mammal species within the study area. This has the potential to have a long-term impact on local mammal population dynamics, affecting both local foraging behaviour and competition for resources and larger scale movements associated with dispersal and/or with breeding behaviour and genetic exchange between populations.

The habitat severance/barrier effect to these other terrestrial mammal species associated with the proposed road development has the potential to affect local mammal populations over the long-term and result in a significant negative effect, at a local geographic scale. Mitigation measures have been designed to minimise the long-tern effects of any barrier effect posed by the proposed road development (see **Section 8.6.7.4.1**).

Disturbance/displacement

In conjunction with any displacement effects associated with habitat loss, increased human presence and/or noise and vibration associated with construction works, has the potential to displace mammal species from both breeding/resting places and from foraging habitat.

However, as disturbance will be intermittent and temporary (in the majority of locations) it is extremely unlikely to result in any long-term effects on the local mammal population or their conservation status. Therefore, disturbance / displacement during construction is unlikely to result in a significant negative effect, at any geographic scale.

Habitat degradation - water quality

During construction, contaminated surface water runoff and/or an accidental spillage or pollution event into any surface water feature has the potential to have a significant negative impact on water quality in Galway Bay and consequently an impact upon marine mammals; either directly (e.g. acute or sub-lethal toxicity from pollutants) or indirectly (e.g. affecting their food supply or supporting habitats).

However, it is considered unlikely that a pollution event of such a magnitude would occur during construction that would have any perceptible effect on water quality in the marine environment, or be any more than temporary in nature. Nevertheless, a precautionary approach is being taken in assuming a level of risk of water quality impacts and detailed mitigation measures have been designed to further minimise the risk of the proposed road development having any perceptible effect on water quality during construction or affecting the conservation status of the marine mammal species in Galway Bay (see **Section 8.6.4**).

8.5.6.4.2 Operational Phase Impacts

Habitat Severance/Barrier Effect

The presence of a new road along the offline sections of the proposed road development, would be certain to act as a permanent barrier to mammal movements locally, either through acting as a physical barrier or as a consequence of road traffic acting as a crossing deterrent.

As discussed above for Badger, elevated sections of the proposed road development (e.g. the proposed River Corrib Bridge and the Menlough Viaduct structures) will serve to maintain a degree of habitat connectivity within each affected Badger territory (Eldridge & Wynn, 2011).

Nevertheless, there will be extensive lengths of the proposed road development that will act as a barrier to species movements within the study area. This has the potential to have a long-term impact on population dynamics, affecting both local foraging behaviour and competition for resources and larger scale movements associated with dispersal and/or with breeding behaviour and genetic exchange between populations.

The habitat severance/barrier effect associated with the proposed road development has the potential to affect local mammal populations over the long-term and result in a significant negative effect, at a local geographic scale. Mitigation measures have been designed to minimise the long-tern effects of any barrier effect posed by the proposed road development (see **Section 8.6.7.4.2**).

Disturbance/displacement

The operation of the proposed road development is likely to have some level of long-term effects on mammal usage of habitat in the vicinity of the proposed road development (Benítez-López et al. 2010). However, this is not likely to affect the species’ conservation status nor result in a likely significant negative effect, at any geographic scale.

Habitat degradation - water quality

There will be outfall points to surface water features from the proposed road drainage network during operation and therefore, a potential impact pathway to affect water quality in Galway Bay. This in turn could affect the marine mammal species therein. The proposed drainage design for the mainline of the proposed road development incorporates pollution control measures (this includes petrol interceptors, wetland and other measures, such as SuDS) followed by either infiltration ponds (where discharging to ground) or attenuation ponds (where drainage will be discharged to the existing surface water/storm sewer), as described in detail in **Chapter 5, Description of Proposed Road Development**.

Those sections of the proposed road drainage that are to be discharged to ground, pose no risk to surface water quality. It is extremely unlikely that the normal operating water quality of the drainage outfalls discharging to the existing surface water/drainage network, even in the unlikely event of a pollution incident, would have any perceptible impact on water quality in receiving watercourses. The functioning and effectiveness of both elements of the road drainage network are discussed in more detail in **Chapter 11, Hydrology**.

Habitat degradation as a result of effects on water quality in Galway Bay during operation is not likely to have any effect on the marine mammal populations or their conservation status, and therefore will not result in a likely significant negative effect, at any geographic scale.

Mortality Risk

The proposed road development will permanently increase the risk of road traffic collisions with mammal species[73]. For some species, such as rodents, the risk may be higher as many such species forage in rough grassland and scrub habitats and may be attracted to foraging along the road margins. However, the hard surfaces of the road infrastructure offer little in the way of potential foraging habitat for mammal species, other than opportunistic scavenging by larger mammal species. The rates of mammal fatality recorded by Haigh (2012) were low (1.2 per 100km) although the presence of dedicated mammal passage facilities were present on sections of the studied roads which is likely to have positively influenced this figure. In the absence of being able to fully quantify the impact on an unmitigated road scheme, a precautionary approach is to conclude that the proposed road development does have the potential to affect the local mammal populations in the long-term, if even only in a local context. Therefore, the proposed road development has the potential to affect the local conservation status of many mammal species, and result in a significant negative effect, at the local geographic scale. Mitigation measures have been designed to reduce this potential impact (see **Section 8.6.7.4.2**).

8.5.7 Invertebrates

8.5.7.1 White-clawed crayfish

As the White-clawed crayfish is not present within the ZoI of the proposed road development, no impacts are predicted.

8.5.7.2 Freshwater pearl mussel

As the Freshwater pearl mussel is not present within the ZoI of the proposed road development, no impacts are predicted.

[73] Haigh (2012) recorded the following mammal road kill species in a study undertaken along the road network between Bandon in County Cork and Caherlistraine in Co. Galway: Rabbit, Hedgehog, Badger, Fox, rodents, Mink, Hare, Otter, Pine marten and Stoat. However, in terms of the protected mammal species discussed in this section, all bar Hedgehog and rodents were infrequently recorded.

Although no freshwater pearl mussel were present with the ZoI of the proposed road development, impacts to salmonid fish species could indirectly affect the Freshwater pearl mussel population in Lough Corrib cSAC; the QI population is in the Owenriff River, c.23km to the north – see **Section 8.5.11** below for impacts on fish species.

8.5.7.3 Marsh whorl snail

8.5.7.3.1 Construction Phase Impacts

Habitat Degradation – Surface Water Quality

An accidental spillage or pollution event affecting the River Corrib, the Coolagh Lakes and surrounding drainage features and springs, and Ballindooley Lough has the potential to negatively impact upon water quality and consequently on the fringing wetland habitat that supports the Marsh whorl snail.

The magnitude and significance of such an impact would be entirely dependent on the nature, scale and duration of the pollution event. Although unlikely, in a worst case scenario this could potentially result in extensive degradation of fringing aquatic habitat in receiving watercourses/waterbodies such that it could, at least in the short-term, no longer support the species. There is the potential for such impacts to have long-term effects on the local Marsh whorl snail population, potentially resulting in localised extinctions. Habitat degradation therefore, has the potential to affect the species' conservation status and result in a significant negative effect, at the local geographic scale. Mitigation measures have been designed to protect water quality during construction (see **Section 8.6.4**).

Habitat Degradation – Groundwater

Any effects on the existing hydrogeological regimes at the Coolagh Lakes and Ballindooley Lough have the potential to negatively impact upon the fringing wetland vegetation that supports the Marsh whorl snail.

Based on the findings of the hydrogeological impact assessment in **Chapter 10, Hydrogeology**, the proposed road development does not pose a risk to the groundwater supply to Ballindooley Lough. The proposed road development does however, have the potential to affect the quantity and quality of groundwater supplying the Coolagh Lakes. Although the magnitude of the impact cannot be fully quantified, on a precautionary basis it is assessed as having has the potential to affect the species' conservation status and result in a likely significant negative effect, at the local geographic scale. Mitigation measures have been designed to protect the existing hydrogeological regime during construction (see **Section 8.6.5**).

Habitat Loss & Mortality Risk

Two wetland habitat areas that will be directly impacted by the proposed road development supported the Marsh whorl snail: at Ballindooley Lough (Ch. 12+350) and a marsh area at Castlegar (Ch. 13+000).

Overall, the Marsh whorl snail was relatively common locally: recorded at 33 sampling sites out of a total of 120. The relatively minor loss of habitat at

Ballindooley Lough and at the Castlegar marsh will not reduce the local wetland habitat resource for the species such that it would be likely to affect its ability to maintain the local population on a long-term basis. Similarly, although there is likely to be some level of mortality associated with construction works at these locations, the species' conservation status locally is not likely to be affected.

Habitat loss and mortality risk during construction are not likely to affect the species' conservation status and will not result in a likely significant negative effect at any geographic scale.

8.5.7.3.2 Operational Phase Impacts

Habitat Degradation – Surface Water & Groundwater

There will be drainage outfall points to two surface water features supporting the Marsh whorl snail: the River Corrib and Ballindooley Lough. Therefore, there is a risk that discharges from the proposed road drainage network could affect water quality and consequently impact upon the Marsh whorl snail or its supporting habitat.

The proposed drainage design consists of a petrol interceptor followed by either attenuation and infiltration ponds (where discharging to ground) or attenuation and constructed wetland (where drainage will be discharged to the existing surface water/drainage network) — as described in detail in **Chapter 11, Hydrology**.

Those sections of the proposed road drainage that are to be discharged to ground, pose no risk to surface water quality. It is extremely unlikely that the normal operating water quality of the drainage outfalls discharging to the existing surface water/drainage network, even in the unlikely event of a pollution incident, would have any perceptible long-term effect on water quality in receiving watercourses. The functioning and effectiveness of both elements of the proposed road drainage network are discussed in more detail in **Chapter 11, Hydrology**.

Although the drainage design will ensure that groundwater quality will be maintained during operation, it is important that infiltration basins are inspected to ensure that karst features do not affect the functioning of them during operation. If this is identified during routine inspections of the infiltration basins then mitigation is required to ensure any issues are addressed so that they continue to function as designed for the operational lifespan of the proposed road development.

Habitat degradation as a result of effects on surface water quality during operation is not predicted to affect the conservation status of the Marsh whorl snail and will therefore, not result in a likely significant negative effect, at any geographic scale.

Habitat degradation as a result of effects on groundwater during operation has the potential to affect the conservation status of the Marsh whorl snail locally and therefore, has the potential to result in a significant negative effect, at the local geographic scale.

8.5.7.4 Marsh fritillary butterfly

The Marsh fritillary butterfly exists in a metapopulation structure — i.e. individual colonies, or populations, that are spatially separated yet interact with one another on some level. Survival and persistence of the metapopulation relies on there being a sufficient network and density of interconnected suitable habitat areas, such that the individual colonies can readily interact and recolonise new habitat patches in response to (what can be) frequent local extinctions. These local extinction events occur in response to factors such as changes in habitat management and condition, weather, resources and intraspecific competition, and/or parasite infestations. In assessing the impacts on the Marsh fritillary butterfly, given the species' population structure, areas of suitable habitat are equally as important to consider as areas where larval webs were recorded.

The natural fluctuations and variations in Marsh fritillary populations are reflected in the larval web records across the four survey years. Comparing the results of the 2013 and 2014 surveys (as both years covered the larger scheme study area): in 2013, only a single habitat patch supported larval webs yet in 2014, 111 larval webs were recorded across the network of suitable habitat patches[74]. This pattern suggests that there was a core population (either in an area within the scheme study area that was not surveyed, or beyond it) which, despite the apparent population crash in 2013, was robust enough to recolonise the locality in 2014. Even comparing the 2015 and 2016 surveys, which both covered a smaller, more targeted survey area focussed on the proposed road development and lands in the immediate vicinity, the number of larval webs recorded increased from 12 in 2015, to 56 in 2016. The same area in 2014 held 39 webs.

The area of suitable habitat mapped for the species across the scheme study area in 2014 totalled approximately 110ha, spread over 139 distinct habitat patches—the densest clusters of which were concentrated around the bog/heath/scrub/wet grassland habitat mosaics at Na Foraí Maola, Lough Inch, An Chloch Scoilte, Ballard, Na hAille, Cappagh and Tonabrocky. Of the suitable habitat patches in these areas, larval webs were recorded in 39 (in total covering an area of c.60ha).

8.5.7.4.1 Construction Phase Impacts

Habitat Loss

The proposed road development will result in the permanent loss of suitable Marsh fritillary habitat, including habitat patches supporting larval webs. The resulting impact will increase habitat fragmentation, not only within individual suitable habitat patches, but also amongst the local network of suitable habitat areas supporting the local Marsh fritillary metapopulation.

In terms of habitat loss in areas where suitable habitat was recorded, and larval webs were present (during any of the surveys carried out between 2013 and 2016), the proposed road development will affect the Marsh fritillary butterfly in the western

74 The majority of the two core areas at Cappagh and Tonabrocky which supported significant numbers of larval webs in 2014 were not surveyed in 2013.

part of the study area; between Bearna and the River Corrib. The area of Marsh fritillary habitat directly affected is approximately 5.2ha.

It is noted in the literature (Bulman 2001; Fowles & Smith 2006) that within 16km^2 sample areas, it was estimated that a minimum area greater than 71ha (and probably 100ha) of suitable habitat was required to give a high degree of probability that a metapopulation would persist long-term. The total coverage of suitable habitat, across the western part of the scheme study area, approximates an area of 16km^2. Therefore, even with the loss of c.5.2ha, the remaining 104.8ha [75] present within the scheme study area is more than the quoted threshold and will probably be sufficient to maintain the local metapopulation in the long-term.

This is evident in the findings of the surveys which demonstrate that even despite localised “crashes” in the local population year on year, there is a sufficient habitat network, and a persisting core colony or population within recolonization range, to allow the metapopulation to recover. Also of note in that regard is that the larger and consistently more densely populated habitat complexes at Lough Inch, Cappagh, and Tonabrocky will remain unaffected by the proposed road development.

Therefore, habitat loss associated with the proposed road development is not likely to affect the species conservation status or result in a likely significant negative effect, at any geographic scale.

Habitat Fragmentation/Severance

Key to Marsh fritillary being able to recolonise or relocate to alternative habitat areas is the spatial relationship between areas of suitable habitat in a network of suitable habitat sites; and principally, their proximity to one another. Therefore, the loss of suitable habitat patches, regardless of their size or whether the species has been recorded there previously, has the potential to result in fragmentation, or habitat isolation, that could potentially affect the long-term viability of the local Marsh fritillary metapopulation.

The Marsh fritillary butterfly is generally a sedentary species. Many studies have reported that the maximum distances over which the species will readily colonise/disperse between habitat areas is 1-2km (Betzholtz et al. 2007; Fowles and Smith 2006); although longer distance movements have been recorded, they are likely to be more infrequent (Warren 1994; Hula et al. 2004; Zimmermann et al. 2011). In applying the more conservative 1km threshold to considering how habitat loss could affect the future prospects of the affected Marsh fritillary metapopulation to colonise suitable habitat areas, the resulting fragmentation would not result in

75 The total area of suitable Marsh fritillary habitat recorded within the scheme study area is likely to only represent a proportion of the actual coverage of suitable habitat available to support the local metapopulation. Although no surveys were undertaken for this project beyond the scheme study area, based on a review of recent orthophotography it would appear that a similar habitat mosaic to that within the scheme study area, extends to the west and north. This, along with the rapid recolonization of the scheme study area between the “crash” year of 2013 and 2014, suggests that a core colony persisted in suitable habitat, within close proximity. Therefore, the quoted area of available habitat, post-construction, is probably a very conservative underestimate.

any of the unaffected suitable habitat areas being permanently isolated by this distance, or greater.

The fragmentation of an individual suitable habitat patch by the proposed road development may also render the remaining fragments unsuitable for the species, due to their small size or due to increased edge effects. Bulman (2001) found that Marsh fritillary did not breed in habitat patches less than 0.1ha in area and this minimum area is considered to be the threshold below which isolated habitat patches would become unusable by the species. This is reflected in the findings of the surveys where all, bar two, of the 39 suitable habitat patches where larval webs had been recorded were greater than 0.1ha in area. Therefore, any remaining suitable habitat fragments below this threshold have been included in the habitat loss calculation. Small, isolated habitat patches are likely to be more susceptible to edge effects and scrub encroachment/succession which could, over the longer-term, result in them becoming unsuitable to support the species. However, even if all such areas were to ultimately become unavailable to the local Marsh fritillary butterfly as a consequence of the habitat fragmentation impact, the areas involved only total c.2ha. In the context of the area of suitable habitat that will be available post-construction (104.8ha) and the additional areas of suitable habitat likely to be present beyond the scheme study area, given the mosaic of heath, bog and wet grassland evident from the orthophotography, this loss is extremely unlikely to affect the long-term viability of the local population or metapopulation.

Therefore, habitat fragmentation/severance is not likely to affect the species conservation status or result in a likely significant negative effect, at any geographic scale.

Mortality Risk

Site clearance works have the potential to result in the mortality of Marsh fritillary butterflies and/or disturb their breeding/resting places; either adults, eggs or larvae, depending on the time of year works are undertaken. The magnitude of the potential impact would be dependent on the species' distribution and abundance across the area in any given year.

Given the distribution of breeding sites across the study area over the survey period, and the resilient nature of the species' natural response to frequent local extinction events, any mortality or disturbance that may result from construction works will most likely be confined to the season within which site clearance works are undertaken and is likely to only affect the local population[76]. Although unlikely, it is possible that the suitable habitat patches affected by the proposed road development could support a significant proportion of the local metapopulation in a given year. If this were to occur, it could potentially affect the species' conservation status locally and result in a significant negative effect, at the local geographic scale. Given the current distribution of the Marsh fritillary butterfly at the county scale (c.46 10km squares), and considering the scale and short-term nature of the predicted impact and the resilient nature of the species' natural response to frequent local extinction events, it would not be likely to affect the

[76] The current distribution for the species within, or adjacent to, the County Galway border covers c.46 10km squares (NPWS, 2013c)

species' conservation status at the county geographic scale, at which the local Marsh fritillary population has been valued.

Mitigation measures to avoid this impact are detailed in **Section 8.6.8.2.1**.

8.5.7.4.2 Operational Phase Impacts

Barrier Effect

From the available literature, there is no definitive evidence to conclude whether the construction or operation of the proposed road development will create a permanent barrier to Marsh fritillary movements. Along the length of the proposed alignment, there are two locations where the proposed road development will sever areas of Marsh fritillary habitat: in the western part of the study area, between Ch. 0+750 and Ch. 8+000; and at the Galway Racecourse where the proposed road development surrounds it on three sides.

The Marsh fritillary butterfly is a species capable of long-distance dispersal movements (Warren 1994; Hula et al. 2004; Zimmermann et al. 2011). It has also evidently crossed the existing road network in the past to colonise habitat at the Galway Racecourse. Considering the above and also that (at least in the western part of the study area) the proposed road development consists of a relatively narrow single carriageway (c.20m), the proposed road development would not be expected to pose a physical barrier to Marsh fritillary movements between the existing network of suitable habitat patches such that it would affect the long-term prospects for either the local populations or the greater metapopulation. Even taking a very precautionary approach, and assuming that the full area of suitable habitat south of the proposed road development would become unavailable, the loss of 7.6ha is not likely to reduce the area of suitable habitat that the local metapopulation is likely to require to ensure it persists over the long-term (see discussion on habitat area requirements above, under the heading of construction phase impacts).

Therefore, any barrier effect associated with the proposed road development is not likely to affect the species' conservation status or result in a significant negative effect, at any geographic scale.

Mortality Risk

It is likely that during operation the proposed road development will result in some level of mortality risk to Marsh fritillary butterfly crossing the proposed road carriageway; although from the available published literature, it is not possible to quantify what that level of risk might be. Of the c.105ha of suitable Marsh fritillary habitat that will remain post-construction, only 7.6ha lies to the south of the proposed road carriageway. The majority (c.97.4ha), which includes the core areas at Cappagh and Tonabrocky, lies to the north. This limits the potential, or need, for Marsh fritillary butterflies to cross the proposed road carriageway and it is not likely that there would be frequent movement of Marsh fritillary butterflies across the proposed road development.

Therefore, it is not likely that any population level effects would arise as a consequence of road mortality that would affect the species' conservation status or result in a significant negative effect, at any geographic scale.

8.5.8 Birds

8.5.8.1 Breeding Birds

The assessment carried out in the NIS for the proposed road development considered the potential for the proposed road development to affect the bird species listed as SCIs of Lough Corrib SPA and Inner Galway Bay SPA for their breeding populations: Black-headed gull, Cormorant and Common tern. That assessment concluded that the proposed road development would not affect their breeding colonies or have any long-term effects on the local breeding populations—which for the purposes of that assessment took a precautionary approach in assuming that all SCI bird species recorded within the scheme study area formed part, or were linked to, the SPA populations. Therefore, for these species, the proposed road development will not affect the conservation status of the breeding populations and will not result in a likely significant negative effect at any geographic scale.

8.5.8.1.1 Construction Phase Impacts

Habitat Loss & Loss of Breeding/Resting Sites

The proposed road development will result in the loss of breeding bird nesting and foraging habitat across the study area. The areas of habitat loss along route of the proposed road development are given in **Section 8.5.4.3** and tabulated in **Table 8.27** for KER habitat types[77]. In the western part of the study area, this is predominantly habitat blocks comprised of mosaics of bracken, scrub, heath and wet grassland. There are sections where the proposed road development crosses more intensively managed agricultural lands, with little vegetation cover for nesting breeding birds, and habitat loss in these areas will have a much lower effect on local bird populations than the more semi-natural habitat mosaics. From the N59 Moycullen Road through to Lackagh Quarry, the habitats affected are amenity grassland and small agricultural fields and a mix of amenity planted woodland (at NUIG) and semi-natural Ash and Hazel woodland (east of the River Corrib). East of Lackagh Quarry a small area of scrub and wet grassland will be lost at Ballindooley Lough. At Castlegar a small area of scrub surrounding a marsh will be affected, near the N83 Tuam Road a small area of Ash/Hazel woodland, and some scrub around the existing N6 Junction. Aside from these areas, the majority of the proposed road development, east of Lackagh Quarry, will largely result in the loss of improved agricultural grassland fields or artificial surfaces associated with the existing road network, business parks and Galway Racecourse.

The primary consequence of habitat loss will be increased competition for resources (e.g. nesting habitat or prey/food source) both between and amongst breeding bird species. The magnitude of this effect will be largely defined by many unquantifiable factors such future land use changes and whether the local habitat resource has currently reached its carrying capacity or not in terms of breeding bird species. For

[77] The loss of these KER habitat types are those most likely to directly affect breeding birds – comprising more than 80ha of scrub, woodland, semi-natural grasslands, wetland habitats (e.g. fens, marsh and reed swamp) and heath habitats, along with almost 12km of hedgerows and treelines.

species with larger home ranges during the breeding season (such as Peregrine falcon, which hunt within 2km of the nest site) habitat loss at the scale of the proposed road development is not likely to have any perceptible effects on breeding success or population dynamics. Another example is Barn owl, which generally hunt within a kilometre of the nest site (Hardy et al., 2009). Within this distance of Menlo Castle, most of the habitats affected are woodland or residential development and not the favoured permanent rough grassland foraging habitat.

The habitat areas that will be lost as a result of the proposed road development form a relatively small part of what are much larger expanses of similar habitat types and mosaics nearby. In that regard, none of the habitat areas that will be lost are unique in the sense that they are not the only areas of that habitat type locally and, either individually or collectively, are not likely to support a significant proportion, or the only population, of any given breeding bird species locally. Although a decline in overall breeding bird abundance could potentially occur at a local level, this is unlikely to affect the local range of the breeding bird species present nor is it likely to affect the ability of these breeding bird populations to maintain their local populations in the long-term. Mitigation measures will be implemented to reduce the effects of habitat loss on breeding birds species locally (see **Section 8.6.9.1.1**).

Mortality Risk

If site clearance works were to be undertaken during the bird breeding season (March to August, inclusive) it is likely that nest sites holding eggs or chicks will be destroyed and birds killed.

Mortality of birds at the scale of the proposed road development, over what is likely to be a single breeding bird season in terms of completing site clearance works, will probably have a short-term effect on local breeding bird population abundance. However, in the longer-term this would be unlikely to affect the ranges of the breeding bird species recorded in the study area nor would it be likely to affect the long-term viability of the local populations.

Mortality of birds during site clearance works is not predicted to affect the conservation status of any of the breeding bird species present within the study area.

Disturbance/displacement

The noise, vibration, increased human presence and the visual deterrent of construction traffic associated with site clearance and construction will disturb breeding bird species and is likely to displace breeding birds from habitat areas adjacent to the proposed development boundary. The magnitude of the impact will be dependent on the type of construction works and their duration; general construction activities will have a less pronounced affect than blasting, in terms of its ZoI, but will be on-going from periods of several months to several years and breeding seasons. Although it is not possible to quantify the magnitude of this potential impact (or the potential effect zone) it could potentially extend for several hundred metres from the proposed road development.

In terms of nesting sites, the most sensitive in terms of disturbance effects (given their low numbers locally, conservation status and proximity of nest sites to the construction works) are Barn owl and Peregrine falcon.

The Barn owl nest site at Menlo Castle is c.140m from the main construction works with landscape planting and installation of a boundary fence proposed adjacent to the castle. The main construction works are likely to be sufficiently removed from Menlo Castle that the resident Barn owl pair will not abandon the nest site and as a consequence no long-term effects on the local population are likely in this regard.

The Peregrine falcon nest site at Lackagh Quarry is immediately adjacent to the proposed road development and construction activities here include rock breaking and rock blasting, and the installation of rock bolts on the exposed cliff faces (for more detail refer to **Chapter 7, Construction Activities**). There is therefore a high risk that the resident pair of Peregrine falcons will abandon the quarry, if works commence part way through the breeding season. As works will be ongoing in the vicinity for a period of c.3 years, this has the potential to have long-term effects on recruitment within the local Peregrine falcon population if the pair repeatedly fail to breed.

Given the temporary to short-term nature of the construction works, disturbance or displacement effects will also be over the short-term and are therefore not likely to affect the conservation status of the majority of affected breeding bird species and will not result in a likely significant negative effect, at any geographic scale.

However, there is the potential for long-term effects on the local Peregrine falcon population and significant negative effects at a county geographic scale. Mitigation measures will be implemented to reduce the effects of construction related disturbance on nesting Peregrine falcon (see **Section 8.6.9.1.1**).

8.5.8.1.2 Operation Phase Impacts

Mortality Risk & Disturbance/Displacement

Road traffic, has been shown to negatively influence local bird populations (Reijnen & Foppen, 2006; Summers et al., 2011): new roads increase mortality risk, road traffic acts as a visual deterrent, and noise associated with road traffic has a negative impact upon bird abundance and occurrence. The magnitude of the potential impact is related to the interaction between a multitude of factors such as species and traffic density (which influences noise levels and mortality risk) and is also influenced by habitat type. Roadside habitat can have a positive effect on bird abundance (e.g. the provision of scrub, either through planting or as a result of edge effects, wetland habitat, or rank grassland habitat). Although any benefits associated with this type of habitat creation are generally on quiet, low-traffic roads and the impacts associated with high density traffic on bird densities generally outweigh any potential benefits.

It is likely that the abundance of breeding bird species will permanently decline near to the proposed road development as a consequence of increased disturbance and mortality from road traffic; the effects of which will reduce to a neutral impact with increasing distance from the proposed road development. Although it is not possible to quantify the magnitude of the potential impact (or the potential road effect zone) based upon the available literature for most breeding bird species, in general it could potentially extend for several hundred metres from the proposed road development. However, where the proposed road development crosses a landscape which is already highly disturbed (i.e. where it will be constructed alongside the existing road network) or of low habitat quality for breeding birds (e.g. the business parks at Ballybrit and Parkmore), the road effect zone will be minimal.

The road effect zone may also act as a population sink during good breeding bird years; where fecundity and juvenile survival rates are high. Less experienced juveniles may be attracted in to the poorer quality habitat affected by road traffic disturbance and with a relatively higher associated mortality risk due to the proximity of the proposed road development. This in turn is likely to affect their breeding success and survival. Another likely consequence of the displacement of breeding birds from the road effect zone is increased competition for resources (e.g. nesting habitat or prey/food sources) both between and amongst breeding bird species.

One exception to this predicted road effect zone is the Barn owl which is likely to be affected at a much greater distance and is discussed separately below. Another, is the Peregrine falcon; a species which is relatively tolerant of human disturbance and road traffic.

Although the proposed road development is predicted to have a long-term effect on local breeding bird populations, even at a local level this is not predicted to affect the ability of almost all local breeding bird species to persist within their current ranges or to maintain their populations long-term — the exception being the Barn owl.

Therefore, the proposed road development is not likely to affect the conservation status of breeding bird species generally (excluding Barn owl and Peregrine falcon, which are discussed separately below) and will not result in a likely significant negative effect, at any geographic scale.

Barn owl

Available published material relating to the potential impacts of road development on Barn owl concludes that the presence of major roads within 2.5km of an active nest site is likely to result in a severe depletion of the local population (Ramsden, 2003). The risk of such effects is likely to be extremely high in the case of the Menlo Castle nest site as it lies c.150m from the proposed road carriageway. Although only a single nest site is within the predicted road effect zone, it is not likely that there will be large numbers of nest sites at a county scale and a long-term decline of the population level at a county scale is likely.

It is unlikely that operational noise levels will result in any disturbance to nesting Barn owl at Menlo Castle (L_{den} 50-60dB). Barn owl are a nocturnal species and therefore, disturbance from road traffic at night (particularly from headlights) and from artificial lighting along the proposed road development is likely to result in some level of displacement of Barn owl from foraging habitat near the proposed road development. However, given the relatively small impact zone of the lighting when compared with the home range of the species (up to 5,000ha in the winter and up to 350ha in the summer (Hardy et al., 2009)), disturbance during operation is not likely to result in any decline in the local Barn owl population or affect its ability to maintain itself over the long-term.

Overall, mortality risk associated with the proposed road development is likely to affect the conservation status of Barn owl and result in a significant negative effect at the county geographic scale. Mitigation measures will be implemented to reduce the mortality risk to Barn owl posed by the proposed road development (see **Section 8.6.9.1.2**).

Peregrine falcon

Although the nest site at Lackagh Quarry used between 2015 and 2017 will not be lost, the nest site used by the breeding pair of Peregrine falcon in 2018 will likely be directly impacted, Despite the retention of the 'traditional' nesting ledge, the presence of a new road at such close proximity and elevated above the existing ground levels, has the potential to permanently displace nesting Peregrine falcon from that nest site. The absence of any alternative suitable nesting sites within the quarry may result in the permanent loss of the quarry as local Peregrine falcon nest site. There are two other quarry sites present locally which are currently not occupied by a Peregrine falcon pair. However, it cannot be predicted with any degree of certainty that Peregrine displaced from Lackagh Quarry would take up residence at these other sites, even with interventions such as creating suitable nesting ledges. The potential loss of one out of three local Peregrine falcon nest sites has the potential to have long-term effects on the local population, affecting the species conservation status locally.

The potential loss of this nesting site is also significant at the county geographic scale. The actual number of nest sites known across counties Galway and Clare is not known[78] but current estimates are on the region of 60-70 nest sites. The loss of one site, that has been regularly in use for many years, is significant in that context.

The potential loss of the nest site at Lackagh Quarry has the potential to result in a likely significant negative effect, at the county geographic scale.

Habitat Degradation – Water Quality

There will be drainage outfalls to all river/stream catchments crossed by the proposed road development. Therefore, there is a risk that discharges from the proposed road drainage network could affect water quality, potentially over the long-term, and consequently impact upon aquatic habitats and bird species, and their prey. In a worst-case-scenario, this could result in a long-term decline in aquatic/wetland bird species abundance and distribution on affected rivers or streams.

The proposed drainage design for the mainline of the proposed road development incorporates pollution control measures (this includes petrol interceptors, wetland and other measures, such as SuDS) followed by either infiltration ponds (where discharging to ground) or attenuation ponds (where drainage will be discharged to the existing surface water/storm sewer), as described in detail in **Chapter 5, Description of Proposed Road Development**.

Those sections of the proposed road drainage that are to be discharged to ground, pose no risk to surface water quality. It is extremely unlikely that the normal

[78] At the time of writing, a national Peregrine falcon census is underway but the results are not yet known.

operating water quality of the proposed drainage outfalls discharging to the existing surface water/drainage network, even in the unlikely event of a pollution incident, would have any perceptible long-term effect on water quality in receiving watercourses. The functioning and effectiveness of both elements of the proposed road drainage network are discussed in more detail in **Chapter 11, Hydrology**).

Habitat degradation is not predicted to affect the conservation status of aquatic or wetland bird species because of effects on surface water or groundwater during operation and will therefore, not result in a likely significant negative effect, at any geographic scale.

8.5.8.2 Wintering Birds

This section of the impact assessment deals with wintering bird species — i.e. those bird species which are SCIs of SPAs for their wintering populations, or are listed on either the BoCCI Red or Amber lists for their wintering populations.

Local bird population figures are based on the sum of the mean populations from I-WeBS summary data for Lough Corrib and Inner Galway Bay (accessed December 2015). However, local bird population figures are likely to be an underestimate of the actual local population due to patchy/incomplete I-WeBS counts and that only two wetland areas are covered in the local area (Inner Galway Bay and Lough Corrib).

8.5.8.2.1 Construction Phase Impacts

Habitat Loss

The proposed road development will result in the loss of suitable wintering bird habitat area from nine of the wintering bird sites surveyed over the winter of 2014/15.

The proposed road development will result in the loss of a mosaic of wet grassland/heathland/scrub habitat at An Chloch Scoilte WB07 (c.2.2ha), Cappagh WB03 (c.4.2ha) and Ballagh WB10 (c.2.8ha). In all cases the habitat loss is along the southern margins of those habitat blocks and will therefore, not result in any fragmentation. Although these sites supported Curlew (on the BoCCI Red List for its wintering population) the numbers were low across all three sites in any of the positive survey months—eight in September 2014, seven in October 2014 and 2 in November 2014. These sites also supported wintering bird species on the BoCCI Amber List. Single Cormorant and Common gull were recorded on only one occasion at survey sites WB07 and WB10, respectively. A single Teal was also only recorded once at WB10. Snipe were recorded frequently across all three survey sites but in relatively low numbers (between one and nine individuals, with almost half being one or two birds). Given that the majority of each habitat block will be unaffected by habitat loss, or fragmentation, and the numbers of wintering birds were low and/or infrequently recorded across the affected wintering bird sites, long-term effects on local wintering bird populations of conservation concern are not likely. There is a small overlap with survey site WB08 at Na Foraí Maola Thoir (c.0.04ha) but this part of the site has been built on and is not of importance for wintering bird species.

At the NUIG Sporting Campus, (WB45) c.3.7ha of the amenity grassland habitat used by wintering birds will be affected by construction phase (for c.18 months). Of this, c.2.8ha will be permanently lost to the proposed Sports Pitches. Considering the availability of alternative amenity grassland habitat on the complex, and elsewhere in Galway City, long-term effects on local wintering bird populations at this site are not likely as a consequence of the habitat loss.

The proposed road development will potentially result in the permanent loss of c.0.9ha of wet grassland habitat from the southern end of the Ballindooley Lough survey site (WB02). This represents approximately 0.7% of the lake and wetland complex. As this portion of habitat was not recorded as being used by wintering birds during the surveys, and the loss of habitat will not fragment the wetland complex, the habitat loss associated with the proposed road development at Ballindooley Lough is not likely to affect the local wintering bird populations using the site.

At Galway Racecourse (WB23), c.0.5ha (or c.1%) of the habitat area within that survey site will be lost. No wintering bird species were recorded using the affected habitat area and as it is on the western edge, the proposed road development will not fragment the site. In terms of wintering birds of conservation concern, the Galway Racecourse site infrequently supported small numbers of Black-headed gull (three, on a single occasion), Common gull (also three on a single occasion), Oystercatcher (one individual on one occasion). More notable is that Curlew were recorded on three occasions (three in October 2014, two in November 2014, and 37 in January 2015) but always in the south-western corner of the survey site, where the proposed road development will not result in any habitat loss.

In WB01, which includes the lands around Ardaun and Doughiska, only small numbers of Black-headed gull were recorded on two occasions. Given the infrequent and low numbers recorded, and that there is an abundance of alternative agricultural grassland habitat locally that will remain unaffected by the proposed road development, the loss of habitat at this survey site is not likely to affect the local Black-headed gull wintering population.

At Lackagh Quarry(WB16), Kestrel were the only wintering bird of conservation concern recordedover the winter of 2014/15 — three were recorded overflying the site in February 2015. Although not confirmed, it is likely that the Menlough/Coolough area is a winter home range for a local pair recorded nesting at Angliham Quarry in 2014, 2015 and 2016. Lackagh Quarry has not been recorded as a roosting site for the species and offers little in the way of foraging habitat for the species. Considering this, and given the availability of alternative foraging habitat within the local area (e.g. open wet grassland and peatland habitats at Coolanillaun), the loss of habitat to the proposed road development is not likely to have any perceptible effect on local wintering Kestrel.

Peregrine falcon nest/roost at Lackagh Quarry during the breeding season and, although not recorded during the winter bird surveys, are also likely to be resident during the winter. With a large hunting range (2-6km from nest site – Hardy *et al.* 2009), and given the availability of alternative foraging habitat within the local area for such an adaptable species in terms of habitat preference, the loss of habitat to the proposed road development is not likely to have any perceptible effect on local wintering Peregrine falcon.

Overall, and considering the cumulative effect of habitat loss across all affected winter bird survey sites, habitat loss is not likely to affect the conservation status of wintering bird species and will not result in a likely significant negative effect, at any geographic scale.

Disturbance/displacement

As the majority of works will be carried out during normal working daylight hours, the potential for construction to disturb wintering birds at night, either foraging or roosting, will not arise. Therefore, the discussion below is focussed on daytime disturbance.

For the purposes of impact assessment and defining disturbance effect distances, construction related disturbance is considered in relation to general construction activities (e.g. visual impact of construction workers and machinery and the associated vibration and more constant/continuous noise levels) and impulse noise disturbance from infrequent noise sources with a high noise level, such as blasting.

General Construction Activity Disturbance

In a report prepared for Humber INCA, Cutts *et al.* (2009) investigated the effects of disturbance on foraging and roosting waterbirds. Based on the findings of that study, in terms of a response to third party disturbance (e.g. human presence), minimal effects would be expected beyond 300m. In terms of construction noise, levels below 50dB would not be expected to result in any response from foraging or roosting birds. Noise levels between 50dB and 70dB would provoke a moderate effect/level of response from birds — i.e. birds becoming alert and some behavioural changes (e.g. reduced feeding activity)—but birds would be expected to habituate to noise levels within this range. Noise levels above 70dB would likely result in 8.31 birds moving out of the affected zone, or leave the site altogether. This is supported by the findings of Wright et al. (2010) which found that average noise levels above 60dB resulted in behavioural responses, with birds abandoning the site in response to noise levels above 70dB.

Noise levels associated with typical construction activity have been calculated in accordance with the methodology set out in BS 5228: Part 1. This standard sets out sound power levels for plant items normally encountered on construction sites, which in turn enables the prediction of noise levels. A variety of items of plant will be in use during the construction works. These will include breakers, excavators, dump trucks, and generators in addition to general road surfacing and levelling equipment. The key phases of works will involve ground breaking, excavation works, fill works, piling of structures, and general road works.

Calculations of indicative noise levels for typical noise sources associated with road construction works at set distances from the construction activity were calculated using the source data from BS 5228:2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1 Noise. The calculations assume that plant items are operating for 66% of the time to obtain an LAeq, 1 hour value. Noise levels are presented in **Table 8.33** for the individual items of plant at specific distances in addition to a cumulative level assuming all plant items associated with the individual phases are operating simultaneously, and at the same distance, for any one scenario. The calculations do not take account of any screening afforded by intervening structures, construction site hoarding etc. and therefore represent a "worst case" scenario.

Table 8.33: Indicative Noise Levels Associated with Construction Works

Site Clearance & Preparation	**Calculated $L_{Aeq, T}$ at distance from works (m)**							
	50m	100m	150m	200m	250m	300m	350m	400m
Pneumatic breaker C.1.6	67	61	58	55	53	52	50	49
Wheeled loader C2-26	63	57	54	51	49	48	46	45
Tracked excavator (loading dump truck) C1-10	69	63	60	57	55	54	52	51
Dozer C.2.10	64	58	55	52	50	49	47	46
Dump Truck (C2.30)	63	57	54	51	49	48	46	45
Combined L_{Aeq} from all works	**73**	**67**	**64**	**61**	**59**	**58**	**56**	**55**
Fill Works	**Calculated $L_{Aeq, T}$ at distance from works (m)**							
	50m	100m	150m	200m	250m	300m	350m	400m
Tracked excavator (loading dump truck) C1-10	69	63	60	57	55	54	52	51
Articulated dump truck (dumping rubble) C1-11	64	58	55	52	50	49	47	46
Wheeled loader C2-26	63	57	54	51	49	48	46	45
Dozer C.2.10	64	58	55	52	50	49	47	46
Dump Truck Tipping fill (C2.30)	63	57	54	51	49	48	46	45
Combined L_{Aeq} from all works	73	**66**	**63**	**60**	**59**	**57**	**56**	**54**
Piling Works	**Calculated $L_{Aeq, T}$ at distance from works (m)**							
	50m	100m	150m	200m	250m	300m	350m	400m
Crawler Mounted Rig (C3.22)	64	58	55	52	50	49	47	46
Tracked Excavator inserting metal cage, (C3.24)	58	52	49	46	44	43	41	40
Concrete Pump & Cement Mixer Truck (C4.24)	51	45	42	39	37	36	34	33

Piling Works	Calculated $L_{Aeq, T}$ at distance from works (m)							
	50m	100m	150m	200m	250m	300m	350m	400m
Diesel Generator (C4.76)	45	39	36	33	31	30	28	27
Angle Grinder (C4.93)	64	58	55	52	50	49	47	46
Combined L_{Aeq} from all works	**68**	**62**	**58**	**56**	**54**	**52**	**51**	**50**
Road Works	**Calculated $L_{Aeq, T}$ at distance from works (m)**							
	50m	100m	150m	200m	250m	300m	350m	400m
Tracked excavator (C2.21)	55	49	46	43	41	40	38	37
Dump Truck (C2.30)	63	57	54	51	49	48	46	45
vibration rollers (C5.20)	59	53	50	47	45	44	42	41
Asphalt Paver & Tipping Lorry (C.5.31)	61	55	52	49	47	46	44	43
Diesel Generator (C4.76)	45	39	36	33	31	30	28	27
Road Rollers (C5.19)	64	58	55	52	50	49	47	46
Combined L_{Aeq} from all works	**69**	**63**	**59**	**57**	**55**	**53**	**52**	**51**

None of the construction activities listed above would be expected to result in any more than a moderate level of disturbance effect on waterbirds at distances beyond 150m. At 300m, noise levels are below 60dB or, in most cases, are approaching the 50dB threshold. Low, or no, effects would be expected for those noise levels. Any landscape features, vegetation cover or buildings between the construction site and winter bird sites would contribute to further reducing the ambient noise at any given distance. Therefore, 300m is considered to be a precautionary buffer in defining the ZoI of disturbance effects.

Impulse Noise Disturbance

In terms of noise levels associated with blasting, behavioural response thresholds would be expected to be similar to those described above for general construction related disturbance — i.e. greater than 60dB. However, calculating a distance whereby blasting would attenuate to below 60dB is less certain given the large number of variables that would influence that calculation (e.g. size of charge used).

Rees et al. (2005) found that impulsive noise disturbance (e.g. airport bird scaring) alerted Whooper swans at distances of up to c.800m. As a precautionary approach, this distance is the zone within which some level of disturbance would be expected from rock blasting. However, it is worth noting that in that study less than a third of birds were alerted and disturbance events were also temporary, with birds resuming undisturbed behaviour within minutes. Therefore, the magnitude of any disturbance effects is likely to be greatest where blasting is occurring regularly, over a prolonged period, and probably at distances less than 800m. The only location along the proposed road development where regular, prolonged blasting is likely to occur in the vicinity of an important wintering bird site (i.e. with high numbers of birds, frequently present) is in the zone between the western approach to Lackagh Tunnel and the proposed N83 Tuam Road Junction. Therefore, Ballindooley Lough is the only winter bird site where blasting may have a significant negative effect on wintering bird species and this is reflected in the discussions below, under the individual species headings.

Impacts on Winter Bird Species of Conservation Concern

In terms of effects on each of the wintering bird species recorded within the ZoI of the proposed road development, the NIS for the proposed road development presents a detailed assessment of those species listed as SCIs of either Lough Corrib SPA or Inner Galway Bay SPA. Based on the abundance and frequency of these bird species recorded at each affected winter bird site, and the assessment methodology relating to disturbance outlined above, it was concluded that there would not be any population level effects. Therefore, for these species disturbance/displacement from construction works will not affect the species' conservation status or result in a likely significant negative effect, at any geographic scale.

The non-SCI wintering bird species of conservation concern present within the ZoI of the proposed road development were: Bittern, Great crested grebe, Little grebe, Merlin, Mute swan, Oystercatcher, Peregrine falcon and Snipe. The potential impact of the proposed road development on the wintering populations of each of these species are discussed below.

Bittern

A single Bittern was recorded at the Coolagh Lakes (WB04) in February 2015, initially in flight and landing in reed beds on the eastern side of the larger northern lake. Bittern is a scarce winter visitor to Ireland and is not included within the BoCCI lists. Ad hoc observations of Bittern in County Galway suggest it was last recorded near Lough Corrib in December 2011[79]; with only two records in the county in the 5 years up to winter 2015. It is likely that construction works will take place over the winter period within 300m of the Coolagh Lakes and therefore, there is the potential for disturbance and displacement of wintering birds, including Bittern. However, only the very northern end of the wetlands at the Coolagh Lakes falls within the ZoI of general construction related disturbance. Blasting may be required during construction within 800m of the Coolagh Lakes, but the requirements are likely to be minimal: i.e. likely to be carried out over periods of days, or a few weeks, with infrequent blasting events at any given location. Thus, displacement from any blasting is unlikely to cause any more than a brief effect at any instance. Given the extensive woodland cover that lies between the wetland/lake habitats and the proposed road development the disturbance effects during construction are likely to be significantly reduced from the 300m and 800m distances related to the construction effects described. Even if Bittern were temporarily displaced from the area, there is an abundance of alternative suitable habitat available to accommodate the species, both surrounding the Coolagh Lakes and to the north of Menlo Castle. Therefore, disturbance from construction works

[79] According to www.irishbirding.com 'Sightings' records Accessed 18th December 2015

is not likely to affect the species' conservation status and will not result in a likely significant negative effect, at any geographic scale.

Great crested grebe

Two Great crested grebe were recorded on a single occasion during the winter bird surveys on the River Corrib corridor (WB12), near the Glenlo Abbey Hotel's boat landing stage. This is estimated at approximately 3.4% of the local population. In the area between the Glenlo Abbey Hotel and Menlo Pier, the River Corrib is within the ZoI of general construction works. Any disturbance effects associated with construction works in this area are likely to be temporary given that it is a pipeline, attenuation facilities and a drainage outfall, and that only a small proportion of the works are within 300m of the River Corrib. Given the scarce records for the species from that part of the River Corrib within the ZoI of the proposed road development, and the temporary nature of the works in the vicinity, there is a low risk of any disturbance or displacement effects. The majority of the river corridor (locally) is beyond the ZoI of any disturbance effects and would be available to accommodate displaced grebes. Therefore, disturbance from construction works is not likely to affect the species' conservation status and will not result in a likely significant negative effect, at any geographic scale.

Little grebe

Little grebe were recorded at four winter bird sites within the ZoI of general construction works and potentially prolonged blasting at Lackagh Quarry: Ballindooley Lough (WB02), the Coolagh Lakes (WB02), west of Lough Inch (WB08) and along the River Corrib corridor (WB12).

Lough Inch is c.740m from the proposed road development, at its nearest point. At this distance, and given that the nearest potential blasting location is c.800m from the lake shore, construction works are not likely to have any perceptible disturbance effects at this site.

Little grebe were recorded frequently at Ballindooley Lough, Coolagh Lakes and on the River Corrib; although five was the maximum number recorded at any one location or on any given survey visit (estimated to be c.4.3% of the local population). As discussed above in relation to Bittern, construction related disturbance at the Coolagh Lakes is not likely to displace wintering birds from most of the lake habitat—even as a consequence of any blasting that might be required, and the effects of which would be of a brief duration.

On the River Corrib, Little grebe were recorded along the river corridor from Galway City to Menlough; the majority of records were from upstream of the NUIG Sporting Campus and between the Coolagh Lakes and Waterside in the city. Both locations are beyond the ZoI of general construction activities and any blasting requirements that may be associated with works within 800m of the River Corrib are likely to be minimal and with only a brief disturbance effect. Construction works near the River Corrib will probably result in some level of construction related disturbance but this will be short-term (c.18 months). Considering that most of the river habitat will be beyond the ZoI of construction related disturbance, and given the low numbers of Little grebe potentially affected along the river, any disturbance/displacement will not have any long-term effects on the species.

As Ballindooley Lough is within the ZoI of (potentially) long-term blasting activity between Lackagh Quarry and the N83 Tuam Road Junction there is the potential for construction works to displace wintering birds from Ballindooley Lough over several winter seasons (estimated/predicted to be three). This could potentially have long term effects on the local population and result in a likely significant negative effect, at the local geographic scale. Mitigation measures will be implemented to limit noise related disturbance during construction (see **Section 8.6.9.2.1**).

Merlin

A single Merlin was recorded in the area west of Lough Inch (WB08) in December 2014; flying to the south of the site. The area covered by the winter bird surveys here that lies within the ZoI of construction works, represents only a small proportion of what is an extensive upland habitat complex extending for more than 50km to the north west, including the Connemara Bog Complex SPA, c.9km away, for which Merlin is a SCI species. Given the scarce presence of the species in habitats near to the proposed road development, and the temporary nature of the works and any potential for disturbance, construction works are not likely to have any long-term effects on the species.

Therefore, disturbance from construction works is not likely to affect the species' conservation status and will not result in a likely significant negative effect at any geographic scale.

Mute swan

Mute swans were recorded at five winter bird sites within the ZoI of general construction works and potentially prolonged blasting at Lackagh Quarry: Ballindooley Lough (WB02), the Coolagh Lakes (WB02), west of Lough Inch (WB08) and along the River Corrib corridor (WB12).

As discussed above, Lough Inch is beyond the disturbance ZoI of the proposed road development and at the Coolagh Lakes disturbance/displacement effects are likely to be minimal and short-term.

On the River Corrib, Mute swan were frequently recorded but, bar a single record of 14 birds in February 2014 (estimated to be c.2.9% of the local population), numbers present ranged from four to eight individuals.

Construction works near the River Corrib will probably result in some level of construction related disturbance but this will be short-term (c.18 months). Considering this, that most of the river habitat will be beyond the ZoI of construction related disturbance, and given the low numbers of Mute swan potentially affected along the river, any disturbance/displacement will not have any long-term effects on the species.

Therefore, disturbance from construction works is not likely to affect the species' conservation status and will not result in a likely significant negative effect, at any geographic scale.

Oystercatcher

Oystercatcher were recorded widely across the study area: the River Corrib corridor (WB12), Merlin Park (WB21), Galway Racecourse (WB23), Ballybane Playing Fields (WB24), NUIG Sporting Campus (WB45), Gort na Bró Playing Fields (WB48) and the Bearna Woods Playing Fields (WB50).

The Merlin Park and Ballybane sites have a significant buffer of urban development between them and the proposed road development, and works in these areas are predominantly on-line. Therefore, no disturbance effects at those sites are likely because of construction works.

Although Galway Racecourse grounds lie within the potential disturbance ZoI, Oystercatcher were only recorded here on one occasion (and only a single individual). In WB12, the species was only recorded on a single occasion and in low numbers (in lands at Menlo Castle where seven individuals were recorded in February 2014). At the Bearna Woods Playing Fields, numbers recorded were also low — one in November 2014, two in December 2014 and five in February 2015. The frequency of use and numbers recorded were similar at the Gort na Bró site—five in both November 2014 and January 2015, three in February 2015 and 20 in March 2015. Therefore, any temporary displacement at these sites during construction will not affect the local population which is estimated to be c.740.

Oystercatcher were recorded at the NUIG Sporting Campus on nine separate occasions over the winter of 2014/15 and it was the most frequently used of the winter bird survey sites by the species. The majority of records ranged between three and 22 individuals; the exception being a record of 34 in December 2014 which is estimated to represent c.4.6% of the local population. It was noted during the surveys at this site that birds were regularly disturbed and temporarily displaced from the playing fields by users of the sports facilities, returning to the same field or to another nearby. This would suggest that Oystercatcher using this site have adapted to a certain degree of habitual disturbance and despite this, frequently use the playing fields. Construction works at the NUIG Sporting Campus will result in some level of construction related disturbance but this will be short-term (c.18 months). Considering this, that there are alternative sites available locally beyond the ZoI of construction related disturbance, and given the relatively low numbers of Oystercatcher potentially affected here, any disturbance/displacement will not have any long-term effects on the species.

Therefore, disturbance from construction works is not likely to affect the species' conservation status and will not result in a likely significant negative effect, at any geographic scale.

Peregrine falcon

During the winter of 2014/15, Peregrine falcon were recorded at one winter bird survey site within the potential ZoI of construction works—the Roadstone Quarry (WB17)—on three occasions in December, February and March when a single bird was observed. The results of the Peregrine falcon survey carried out in 2016 confirmed the presence of three local breeding pairs, and it would be expected that they would maintain a local presence over the winter period.

Peregrines are highly adaptable species and not highly sensitive to construction related disturbance away from the nest site; as evidenced by the species regularly breeding in active quarry sites and in the urban environment. Therefore, construction works are not likely to have any perceptible effect on the local population during the winter period, is not likely to affect the species' conservation status and will not result in a likely significant negative effect, at any geographic scale.

Snipe

Snipe were distributed widely across the study area: recorded at eight of the winter bird survey sites. Although Snipe were frequently recorded across these sites, the numbers were generally low (<10 birds). The exception being records of 28 and 34 at Ballindooley Lough in December 2014 and March 2015, respectively.

In the western part of the study area, four winter bird sites within the ZoI of construction related disturbance supported wintering Snipe — Cappagh (WB03), An Chloch Scoilte (WB07), west of Lough Inch (WB08) and Ballagh (WB10). The areas within those sites potentially affected by disturbance during construction represent only a small proportion of the locally available habitat resource for the species during the winter (i.e. rough wet grassland/heath habitat offering good ground cover). Given the low numbers potentially affected at these sites, and the temporary nature of any construction related disturbance, disturbance/displacement effects are not likely to affect the local Snipe population in the long-term.

Where the proposed road development crosses the River Corrib (WB12), there is little habitat suitable for the species within the disturbance ZoI. As discussed above for Bittern, Little grebe and Mute swan, at Coolagh Lakes disturbance/displacement effects are likely to be minimal and short-term at most. Therefore, even temporary effects during construction are unlikely to affect the local population.

The Terryland River Valley (WB14) is beyond the ZoI of general construction works with a buffer of residential development between it and the proposed road development. Even if prolonged blasting in this area were required during construction, the effects would remain brief and most of this winter bird site would remain unaffected by disturbance.

As Ballindooley Lough is within the ZoI of (potentially) long-term blasting activity between Lackagh Quarry and the N83 Tuam Road Junction there is the potential for construction works to displace wintering birds from Ballindooley Lough over several winter seasons (estimated/predicted to be three). This could potentially have long term effects on the local population and result in a significant negative effect, at the local geographic scale. Mitigation measures will be implemented to limit noise related disturbance during construction (see **Section 8.6.9.2.1**).

<u>Impacts on Important Winter Bird Sites</u>

Given their SPA status, Lough Corrib SPA and Inner Galway Bay SPA are the most sensitive sites for wintering birds locally. A detailed assessment of the potential for the proposed road development to affect both Lough Corrib SPA and Inner Galway Bay SPA is presented in the NIS. This assessment concluded that the proposed road development would not result in an adverse effect on the integrity of either SPA.

However, this conclusion was dependant on the implementation of mitigation measures relating to the protection of surface water, groundwater and disturbance—which are also reflected in the mitigation strategy presented in **Section 8.6** of this chapter.

Ballindooley Lough is also considered to be a locally important wintering bird site given the diversity of bird species of conservation concern for their wintering populations recorded there; fourteen in total, which included species listed as SCIs for Lough Corrib SPA and Inner Galway Bay SPA. The site regularly supported Coot, Curlew, Teal, Tufted duck and Shoveler—all species listed as SCIs for the nearby Lough Corrib SPA and Inner Galway Bay SPA. Although recorded less frequently and/or in low numbers, other SCI bird species recorded over the winter period were Bar-tailed godwit, Black-headed gull, Cormorant, Grey heron, Lapwing and Wigeon. The BoCCI Amber listed wintering species Little grebe, Mute swan and Snipe were also regularly recorded at Ballindooley Lough. As Ballindooley Lough is within the ZoI of (potentially) long-term blasting activity between Lackagh Quarry and the N83 Tuam Road Junction there is the potential for construction works to displace wintering birds from Ballindooley Lough over several winter seasons (estimated/predicted to be three). This could potentially have long term effects on the local population and result in a significant negative effect, at the local geographic scale. Mitigation measures will be implemented to limit noise related disturbance during construction (see **Section 8.6.9.2.1**).

The River Corrib corridor (including the NUIG Sporting Campus) and Coolagh Lakes were also important sites for wintering birds of conservation concern. Between them they supported three BoCCI Red list species (Black-headed gull, Curlew and Redshank) and ten Amber listed species—Cormorant, Coot, Great-black backed gull, Little grebe, Mute swan, Snipe, Teal, Common gull, Great crested grebe and Oystercatcher. The areas where most of these species were most frequently recorded (and recorded in the greatest numbers) are generally in the lower parts of the river between Coolagh Lakes and the Salmon Weir, or upstream of Menlo Castle. The exception being Oystercatcher who were frequently recorded at the NUIG Sporting Campus but there are alternative amenity grassland areas available to the species elsewhere in the complex.

As discussed above, and in the NIS, in relation to the species recorded at each of these sites, the potential impacts associated with the proposed road development, either at each site or cumulatively, are not likely to affect the conservation status of the local wintering populations at these winter bird sites and will not result in a likely significant negative effect, at any geographic scale.

Habitat Degradation – Surface Water Quality

During construction, contaminated or heavily silted surface water runoff, pump discharges and/or an accidental spillage or pollution event into any surface water feature has the potential to have a significant negative impact on water quality and consequently on aquatic habitats and species supporting the wintering bird populations. This could be either directly (e.g. bird species coming into direct contact with pollutants) or indirectly (e.g. acute or sub-lethal toxicity from pollutants affecting their food supply or supporting habitats).

The effects of frequent and/or prolonged pollution events in lake systems could potentially have significant long-term effects. It is considered unlikely that a pollution event of such a magnitude would occur during construction, or be any more than temporary in nature. Nevertheless, a precautionary approach is being taken in assuming a level of risk of water quality impacts and detailed mitigation measures are required to further minimise the risk of the proposed road development having any perceptible effect on water quality during construction.

Habitat degradation as a result of effects on surface water quality during construction has the potential to affect the conservation status of affected wintering bird species and result in a likely significant negative effect, at a local geographic scale. Mitigation measures have been designed to protect water quality during construction (see **Section 8.6.4**).

Habitat Degradation – Groundwater

Any effects on the existing hydrogeological regimes at Coolagh Lakes and Ballindooley Lough have the potential to negatively impact upon the aquatic habitats and wintering bird species they support.

Based on the findings of the hydrogeological impact assessment in **Chapter 10, Hydrogeology**, the proposed road development does not pose a risk to the groundwater supply to Ballindooley Lough. The proposed road development does however, have the potential to affect the quantity of groundwater supplying the Coolagh Lakes. Although the magnitude of the impact cannot be fully quantified, on a precautionary basis it is assessed as having has the potential to affect winter bird usage of the Coolagh Lakes and result in a likely significant negative effect, at the local. Mitigation measures have been designed to protect the existing groundwater regime during construction (see **Section 8.6.5**).

8.5.8.2.2 Operation Phase Impacts

Disturbance/displacement

During operation, the proposed road development has the potential to disturb and displace wintering bird species from habitat near the proposed road development because of the noise and visual disturbance associated with road traffic. The focus of research, and attempting to quantify, the effect of operational roads on bird populations has been largely focussed on breeding populations. Although the operational disturbance/displacement effect cannot be quantified it would be expected to be much less than the 300m ZoI associated with construction works. Most species of wintering birds are likely to habituate to the presence of a new road, particularly when there is a barrier in place, as is the case for the proposed road development in the form of the boundary fencing or where the proposed road is in a deep cutting. Also, background noise levels are predicted to increase in the western part of the study area from a current range of 45-55dB to between 50 and 60dB during operation—a noise level at which birds would not be expected to be displaced from the area. In the zone between the N83 Tuam Road and the existing N6, background noise levels are currently in the 50-60dB range and any operational noise/traffic is not likely to alter the existing baseline effect on wintering birds using habitats locally.

Although there is still likely to be some level of displacement effect, a perceptible effect would be expected to be limited to habitats immediately adjacent to the proposed road development. Although it is likely to add to the effect of habitat loss, in terms of additional habitat area unavailable or unlikely to be used by wintering birds, it is not predicted to have a detrimental population level effect—particularly given the relatively infrequent and/or low numbers of wintering birds generally recorded at affected winter bird sites.

Therefore, any displacement of birds from habitat areas during operation of the proposed road development is not likely to affect the conservation status of wintering bird species and will not result in a likely significant negative effect, at any geographic scale.

Mortality Risk

The proposed River Corrib Bridge poses a collision risk to birds commuting along the river corridor. The risk of birds colliding with a bridge is dependent on many factors such as bridge design, visibility (bridge strikes are more likely during poor weather conditions or at night), the structure of the surrounding habitat, the bird species present, their frequency of occurrence within the impact zone (and flight height relative to the bridge structure), and their relative susceptibility to colliding with structures.

Surveys carried out in 2005/2006 as part of the 2006 Galway City Outer Bypass Scheme (RPS, 2006) recorded the following SCI species flying through the proposed bridge site for that scheme over the survey period (52 surveys encompassing 104 hours of observations): Hen harrier, Coot, Black-headed gull, Common gull, and Common tern. The most frequently recorded of these were Black-headed gull, Common gull and Cormorant; Hen harrier and Coot were only recorded once, Common tern were observed crossing the bridge site on only 43 occasions and generally low over the water (<5m).

The bridge structure is clear-span with no supporting cable structures and as such, poses a minimal risk to wintering birds passing along the river corridor. Given the bird numbers and crossing frequencies observed during the 2006 surveys, a bridge such as that proposed in the design (refer to **Section 5.5.4.6** of **Chapter 5, Description of Proposed Road Development**) would not be expected to pose a collision risk of a magnitude that it would result in long-term effects on local bird populations.

Nor would the presence of the proposed road development outside of the River Corrib corridor be expected to pose any significant collision risk to winter birds moving between the coast, Lough Corrib or any of the other winter bird survey sites at which they were recorded. Particularly given that to move between sites outside of the river corridor at present birds must fly over the existing road network and urban infrastructure in Galway City.

Therefore, any collision risk posed by the proposed road development is not likely to affect the conservation status of wintering bird species and will not result in a likely significant negative effect, at any geographic scale.

Habitat Degradation – Surface Water

There are proposed drainage outfalls to all river/stream catchments crossed by the proposed road development. Therefore, there is a risk that discharges from the proposed road drainage network could affect water quality, potentially over the long-term, and consequently impact upon the aquatic environment and supported bird species. In a worst-case-scenario, this could result in a long-term decline in aquatic/wetland bird species abundance and distribution on affected rivers or lakes.

The proposed drainage design for the mainline of the proposed road development incorporates pollution control measures (this includes petrol interceptors, wetland and other measures, such as SuDS) followed by either infiltration ponds (where discharging to ground) or attenuation ponds (where drainage will be discharged to the existing surface water/storm sewer), as described in detail in **Chapter 5, Description of Proposed Road Development**.

Those sections of the proposed road drainage that are to be discharged to ground, pose no risk to surface water quality. It is extremely unlikely that the normal operating water quality of the drainage outfalls discharging to the existing surface water/drainage network, even in the unlikely event of a pollution incident, would have any perceptible long-term effect on water quality in receiving watercourses. The functioning and effectiveness of both elements of the proposed road drainage network are discussed in more detail in the hydrology chapter (**Chapter 11, Hydrology**).

Habitat degradation because of effects on surface water or groundwater during operation are not predicted to affect the conservation status of aquatic or wetland bird species and will therefore, not result in a likely significant negative effect, at any geographic scale.

8.5.9 Amphibians

8.5.9.1 Construction Phase Impacts

Habitat Loss

The construction of the proposed road development will result in the permanent loss of both confirmed and potentially suitable amphibian habitat within the proposed development boundary. The presence of potentially suitable amphibian breeding habitat is of note as, even though both Common frog and Smooth newt were only confirmed at a small number of sites within the proposed development boundary (see **Figures 8.10.1** to **8.10.8**), it is possible that any wetland/peatland habitat or drainage ditches could be colonised and used by this species at the time of construction.

Given the low number of habitat features supporting amphibian species directly impacted by the proposed road development, and that these areas supported relatively few individuals, and the abundance of alternative suitable habitat available locally, the effects of habitat loss associated with construction works are unlikely to affect the ability of the local frog or newt populations to maintain themselves in the long-term.

Therefore, habitat loss associated with the proposed road development is not likely to affect the species' conservation status or result in a likely significant negative effect, at any geographic scale.

As amphibian breeding habitat will be directly impacted by the proposed road development, and given the legal protection afforded to amphibian species under the Wildlife Acts (which prohibits wilful destruction or interference with an amphibian breeding or resting places), a mitigation strategy has been developed (see **Section 8.6.10.1**).

Disturbance & Mortality Risk

Site clearance works also have the potential to result in disturbance to, and the direct mortality of, Common frog and Smooth newt. The potential for direct mortality to occur, and the magnitude of any effects, would be expected to be greater where (a) suitable habitat exists and either Common frog and/or Smooth newt have been previously recorded (b) works affecting suitable habitat are undertaken during the breeding season, when adults and/or frog spawn/newt eggs may be present, or during the winter hibernation period when individuals are in refugia. Based on the survey results, the number of individuals that would potentially be at risk is low and would be unlikely to affect the local populations in the long-term.

Therefore, the proposed road development is not likely to affect the species' conservation status in that regard or result in a likely significant negative effect, at any geographic scale.

Amphibian species have been confirmed using habitat areas within, and immediately adjacent to, the proposed road development that have the potential to be killed, injured, or affected by construction related disturbance. Given the legal protection afforded to amphibian species under the Wildlife Acts, which prohibits their intentional killing or injury, or the wilful interference with an amphibian breeding or resting places, a mitigation strategy has been developed (see **Section 8.6.10.1**).

Habitat Severance/Barrier Effect

The temporary to short-term physical disruption of the existing landscape during site clearance and construction will fragment wetland and peatland habitats used by amphibian species. As a temporary to short-term impact, this is unlikely to present a significant barrier to the movement of amphibian species such that it would affect the local Common frog or Smooth newt populations in the long-term. Therefore, habitat severance during construction and any associated barrier effect are not predicted to result in a likely significant negative effect to amphibian species, at any geographic scale.

Habitat Degradation – Surface Water Quality

An accidental spillage or pollution event into a surface water feature supporting Common frog or Smooth newt will probably have a negative impact. The magnitude and significance of such an impact would be entirely dependent on the nature, scale and duration of the pollution event. Although unlikely, in a worst case scenario this could result in extensive degradation of amphibian habitat and/or the mortality of amphibians in affected habitats. There is the potential for such impacts to have long-term effects on the local populations of both the Common frog and the Smooth newt and result in a likely significant negative effect, at the local geographic scale. Habitat degradation therefore, has the potential to affect the species' conservation status and result in a likely significant negative effect, at the local geographic scale. Mitigation measures have been designed to protect water quality during construction (see **Section 8.6.4**).

8.5.9.2 Operational Phase Impacts

Habitat Severance/Barrier Effect

The presence of the proposed road development will create a permanent barrier in the landscape to the movement of Common frog and Smooth newt. This is likely to affect foraging behaviour and dispersal corridors, e.g. the movement of species between breeding and hibernation sites. Populations on the fringes of Galway City may be isolated from habitat areas and populations beyond, having long-term effects on genetic diversity and gene flow, at a local geographic scale.

Habitat severance and barrier effect has the potential to have long-term effects on the local populations of both the Common frog and the Smooth newt, affect the species' conservation status and result in a likely significant negative effect, at the local geographic scale. Mitigation measures have been designed to minimise the long-tern effects of any barrier effect posed by the proposed road development (see **Section 8.6.10.2**).

Mortality Risk

Amphibians species are vulnerable to road mortality and the presence of the proposed road development will pose a permanent mortality risk to Common frog and Smooth newt. Although it is not possible to quantify the magnitude of this impact, it is unlikely to have long-term effects that would result in a decline of the local Common frog and Smooth newt populations. Particularly, given the high degree of permeability across the proposed road development included within the design which will minimise the potential interaction of amphibians with the proposed road carriageway.

Therefore, mortality risk is not likely to affect the species' conservation status or result in a likely significant negative effect, at any geographic scale.

Habitat Degradation – Surface Water Quality

There will be outfall points to surface water features from the proposed road drainage network during operation. Therefore, there is a risk that discharges from the proposed road drainage network could affect water quality in receiving surface water features and consequently impact upon amphibian habitat.

The proposed drainage design for the mainline of the proposed road development incorporates pollution control measures (this includes petrol interceptors, wetland and other measures, such as SuDS) followed by either infiltration ponds (where discharging to ground) or attenuation ponds (where drainage will be discharged to the existing surface water/storm sewer), as described in detail in **Chapter 5, Description of Proposed Road Development**.

Those sections of the proposed road drainage that are to be discharged to ground, pose no risk to surface water quality. It is extremely unlikely that the normal operating water quality of the drainage outfalls discharging to the existing surface water/drainage network, even in the unlikely event of a pollution incident, would have any perceptible long-term effect on water quality in receiving watercourses. The functioning and effectiveness of both elements of the proposed road drainage network are discussed in more detail in **Chapter 11, Hydrology**.

Habitat degradation as a result of effects on surface water quality during operation is not predicted to affect the conservation status of amphibian species and will therefore, not result in a likely significant negative effect, at any geographic scale.

8.5.10 Reptiles

8.5.10.1 Construction Phase Impacts

Habitat Loss

Construction of the proposed road development will result in the permanent loss of Common lizard habitat within the proposed development boundary (see **Figures 8.10.1** to **8.10.8**). There are three distinct areas, where Common lizard were recorded, that are affected directly by the proposed road development: a mosaic of heath, scrub, bracken and wet grassland at Na Foraí Maola/An Chloch Scoilte (Area A); a similar habitat mosaic between Bearna Woods and na hAille (Areas B & C); and, at Ballagh (Areas E & F). This is consistent with the species favouring structurally diverse habitat mosaics to provide foraging areas, refuges and hibernacula, and basking sites within their territories.

In all areas, only single individual Common lizard were recorded on any given visit. Given the relatively low numbers of Common lizard that are likely to be affected, and the abundance of alternative suitable habitat available locally, the effects of habitat loss associated with construction works are unlikely to affect the long-term viability of the local Common lizard population. Therefore, habitat loss is not likely to affect the species' conservation status or result in a likely significant negative effect, at any geographic scale.

As Common lizard habitat will be directly impacted by the proposed road development, and given the legal protection afforded to the species under the Wildlife Acts (which prohibits wilful destruction or interference with their breeding or resting places), a mitigation strategy has been developed (see **Section 8.6.11.1**).

Disturbance & Mortality Risk

Site clearance works have the potential to result in disturbance to, and the direct mortality of, Common lizard. The potential for direct mortality to occur, and the magnitude of any effects, would be expected to be greatest where (a) suitable habitat exists and Common lizard have been previously recorded (b) works affecting suitable habitat are undertaken during the winter hibernation period (October to mid-March) and affect potential hibernacula (e.g. stone walls), when lizards are less active and therefore less able to escape any works being undertaken.

Based on the survey results, the number of individuals that would potentially be at risk is low and would be unlikely to affect the local populations in the long-term. Therefore, disturbance or mortality risk are not likely to affect the species' conservation status or result in a likely significant negative effect, at any geographic scale.

Common lizard have been confirmed using habitat areas within, and immediately adjacent to, the proposed road development and there is therefore, the potential for individuals to be killed, injured, or affected by construction related disturbance. Given the legal protection afforded to the Common lizard under the Wildlife Acts (which prohibits their intentional killing or injury, or the wilful interference with their breeding or resting places) and a mitigation strategy has been developed (see **Section 8.6.11.1**).

Habitat Severance/Barrier Effect

The temporary to short-term physical disruption of the existing landscape during site clearance and construction will fragment habitat used by Common lizard. As a temporary to short-term impact, this is unlikely to present a significant barrier to the movement of the species such that it would affect the local Common lizard population in the long-term. Therefore, habitat severance during construction and any associated barrier effect are not likely to affect the species' conservation status and are not predicted to result in a likely significant negative effect to the Common lizard, at any geographic scale.

8.5.10.2 Operational Phase Impacts

Habitat Severance/Barrier Effect

The presence of the proposed road development will create a permanent barrier in the landscape to the movement of Common lizard. This is likely to affect foraging behaviour and dispersal corridors, e.g. the movement of individuals within their territories and between breeding and hibernation sites. Populations on the fringes of Galway City may be isolated from habitat areas and populations beyond, having long-term effects on genetic diversity and gene flow, at a local geographic scale.

Habitat severance and barrier effect has the potential to have long-term effects on the local Common lizard population, affect the species' conservation status and result in a likely significant negative effect, at the local geographic scale. Mitigation measures have been designed to minimise the long-tern effects of any barrier effect posed by the proposed road development (see **Section 8.6.11.2**).

Mortality Risk

Common lizard are vulnerable to road mortality and the presence of the proposed road development will pose a permanent mortality risk to the species. Although it is not possible to quantify the magnitude of this impact, it is unlikely to have long-term effects that would result in a decline of the local Common lizard population. Particularly, given the high degree of permeability across the proposed road development included within the proposed design which will minimise the potential interaction of lizards with the proposed road carriageway.

Therefore, mortality risk is not predicted to affect the species' conservation status or result in a likely significant negative effect to amphibians, at any geographic scale.

8.5.11 Fish

8.5.11.1 Construction Phase Impacts

Habitat Loss

The proposed road development will result in the permanent loss of fisheries habitat where it crosses Sruthán na Líbeirtí, the Trusky Stream, the Bearna Stream (and tributary), the Tonabrocky Stream, the Knocknacarra Stream. A reduction in habitat availability could potentially have long-term effects on fish populations within a given river/stream catchment.

Sruthán na Líbeirtí

Sruthán na Líbeirtí is crossed by the proposed road development at two locations: between Ch. 0+650 and Ch. 0+750 (refer to **Figure 5.1.1**) where the length of channel directly affected is c.130m, and between Ch. 0+850 and Ch. 1+000 where c.120m will be lost. There is an additional 240m of the watercourse that lies within, or along, the proposed development boundary and is likely to be affected to some degree by construction, construction works could potentially result in further habitat loss. Construction works to install the proposed drainage outfall and road carriageway near where the stream passes beneath the R336 has the potential to result in further habitat loss, although the areas involved are likely to be small (<10m^2). The impact associated with the loss of instream habitat will be offset slightly by the creation of a new section of river channel, c.40m in length.

Sruthán na Líbeirtí is a seasonal watercourse with low fisheries value in the upper reaches, where it is impacted by the proposed road development. Considering this and the design requirements relating to new crossing structures and the proposed realigned channel, the loss of habitat is predicted not to affect the conservation status of the fish species within that catchment and will not therefore, result in a likely significant negative effect, at any geographic scale.

Trusky Stream

Approximately 160m of instream habitat will be lost on the Trusky Stream (Ch. 2+750 to Ch. 2+900 - refer to **Figure 5.1.1** and **Figure 5.1.2**) with a new channel, c.60m in length, being constructed in its place. There is also an additional 65m of the watercourse that lies within the proposed development boundary and is likely to be affected to some degree by construction works, e.g. the construction of the proposed drainage outfall will require installing a permanent structure on the stream bank.

The Trusky Stream is a seasonal watercourse with low fisheries value in the upper reaches, where it is impacted by the proposed road development. Considering this, the loss of habitat is not likely to affect the conservation status of the fish species within that catchment and will not therefore, result in a likely significant negative effect, at any geographic scale.

Bearna Stream

The Bearna Stream is crossed by the proposed road development at Ch. 4+125 (refer to **Figure 5.1.3**) where c.40m of existing instream habitat will be lost. There is an additional 285m of the watercourse that lies within, or along, the proposed development boundary and is likely to be affected to some degree by construction. Construction works could potentially result in further habitat loss such as that associated with installing the drainage outfall from the attenuation ponds. At Ch. 3+950, approximately 40m of instream habitat in a small tributary of the Bearna Stream will be lost; there is also c.110m of additional stream channel within the proposed development boundary with the same potential construction impacts as outlined above for the main channel of the Bearna Stream.

The main channel of the Bearna Stream is more than 4km in length. Considering that the linear length of stream channel that will be lost represents less than 1% of the total, the habitat loss is not likely to be of a magnitude to affect the conservation status of the fish species within that catchment and will not therefore, result in a likely significant negative effect, at any geographic scale. The unnamed tributary of the Bearna Stream is a seasonal watercourse with a relatively lower fisheries value in the upper reaches, where it is crossed by the proposed road development. Considering this, the loss of habitat is not likely to affect the conservation status of the fish species within that catchment and will not therefore, result in a likely significant negative effect, at any geographic scale.

Tonabrocky Stream

Approximately 450m of the Tonabrocky Stream channel will be lost as a result of the proposed road development between Ch. 4+850 and Ch. 5+225 (refer to **Figure 5.1.4**). As with many of the other watercourses crossed by the proposed road development, a further c.80m of the stream channel lie within the proposed development boundary and may also be directly impacted by construction works. A new section of stream channel, c.250m in length, which will offset the habitat loss to a degree.

The main channel of the Tonabrocky Stream is more than 5km in length. Although the linear length of stream channel that will be lost represents c.9% of the total, when the new length of stream channel is considered (reducing the permanent loss to c.4%) the habitat loss is not likely to be of a magnitude to affect the conservation status of the fish species within that catchment, particularly given that the impacted area is in the upper reaches of the catchment where the fisheries value was assessed as low. Habitat loss on the Tonabrocky Stream will not therefore, result in a likely significant negative effect, at any geographic scale.

Knocknacarra Stream

As a seasonal stream with a low fisheries value (where impacted by the proposed road development), the loss of habitat is predicted not to affect the conservation status of the fish species within that catchment and will not therefore, result in a likely significant negative effect, at any geographic scale.

River Corrib

There are no instream works proposed at the River Corrib. Habitat loss here will be restricted to the permanent loss of riparian/bankside habitat to install the drainage outfalls; one on each bank of the river which will affect c.3m of riparian habitat (refer to **Figure 5.1.7** and for habitats **Figures 8.14.7** and **8.15.7**). In the context of the River Corrib, where there is no spawning habitat or habitat suitable to support lamprey ammocoetes present in the immediate vicinity of the proposed River Corrib Bridge, this level of habitat loss is not likely to have any perceptible impact upon the fish species using the river. Therefore, habitat loss is not likely to have any long-term effect on the fish populations of the River Corrib or their conservation status, and therefore will not result in a likely significant negative effect, at any geographic scale.

Even though habitat loss is not predicted to result in any likely significant negative effect on affected watercourses/catchments, mitigation measures are proposed to minimise the loss of fisheries habitat, to protect that which is being retained within the proposed development boundary, and through the design of new channels and the culverts, minimise its effects on the local fish populations.

Coolagh Lakes, Ballindooley Lough and Galway Bay

There will be no habitat loss associated with the proposed road development at the Coolagh Lakes, Ballindooley Lough or in Galway Bay.

Habitat Degradation – Surface Water Quality

During construction, contaminated or heavily silted surface water runoff, pump discharges and/or an accidental spillage or pollution event into any surface water feature has the potential to have a significant negative impact on water quality and consequently on aquatic habitats and fish species, and potentially also in the marine environment downstream. This could be either directly (e.g. acute or sub-lethal toxicity from pollutants or siltation events damaging spawning habitat downstream) or indirectly (e.g. affecting their food supply or supporting habitats).

The effects of frequent and/or prolonged pollution events in a river system have the potential to be extensive and far-reaching and could potentially have significant long-term effects. It is considered unlikely that a pollution event of such a magnitude would occur during construction, or be any more than temporary in nature. Nevertheless, a precautionary approach is being taken in assuming a level of risk of water quality impacts and detailed mitigation measures are required to further minimise the risk of the proposed road development having any perceptible effect on water quality during construction.

Habitat degradation as a result of effects on surface water quality during construction has the potential to affect the conservation status of affected fish species and result in a likely significant negative effect, at a local geographic scale. Mitigation measures have been designed to protect water quality during construction (see **Section 8.6.4**).

Habitat Degradation – Groundwater

Any effects on the existing hydrogeological regimes at the Coolagh Lakes and Ballindooley Lough have the potential to negatively impact upon the aquatic habitats and the fish species they support.

Based on the findings of the hydrogeological impact assessment in **Chapter 10, Hydrogeology**, the proposed road development does not pose a risk to the groundwater supply to Ballindooley Lough. The proposed road development does however, have the potential to affect the quantity and quality of groundwater supplying the Coolagh Lakes. Although the magnitude of the impact cannot be fully quantified, on a precautionary basis it is assessed as having the potential to affect fish species' conservation status in the Coolagh Lakes and result in a likely significant negative effect, at the local geographic scale. Mitigation measures have been designed to protect the existing hydrogeological regime during construction (see **Section 8.6.5**).

Mortality Risk

Construction works to install culverts on Sruthán na Líbeirtí, the Trusky Stream, the Bearna Stream (and tributary), the Tonabrocky Stream, the Knocknacarra Stream and the River Corrib will require instream works, and in some cases realignment of a section of the stream channel. Instream works, or works associated with channel diversions, stream realignments or general construction activities (e.g. dewatering channels or water abstraction for dust control), have the potential to result in the direct mortality of fish species. This section assesses the risk associated with mortality due to species interacting with construction vehicles, machinery such as pumps, or as a result of dewatering. The potential effects of accidental pollution events, which can also result in fish mortality, are discussed separately under the heading of *Habitat Degradation – Surface Water*.

Given the seasonal nature of the upper reaches of many of the streams, where the proposed road development will be impacting upon the channel, and the low numbers of fish species recorded there during the electrofishing surveys, the mortality risk posed by the construction works is unlikely to affect the conservation status of any of the fish species present in the catchments of Sruthán na Líbeirtí, the Trusky Stream, the Bearna Stream (and tributary), the Tonabrocky Stream, or the Knocknacarra Stream.

Instream works on the River Corrib are limited to construction of the drainage outfalls (one on each river bank) which will require the installation of a head wall and concrete base. Given the scale of the works, they do not pose a risk of fish mortality such that it is likely to affect the conservation status of any of the fish species present in the River Corrib catchment.

The mortality risk from construction works is not likely to have any long-term effect on the local fish populations or their conservation status, and therefore will not result in a likely significant negative effect, at any geographic scale.

Given the legal protection afforded to fish species under the Fisheries Acts, a mitigation strategy has been developed to avoid an offence being committed during construction works (see **Section 8.6.12.1**).

Disturbance/Displacement

Increased human presence, and noise and vibration associated with the construction works (e.g. the installation of culverts and piles) is likely to result in the displacement of fish species from the area. long-term disturbance/displacement effects on the local fish populations are not likely given the temporary nature of any vibration associated with the pile driving, and the short-term nature of general construction works (which if carried out during normal working hours, would be of a limited duration each day), that there are no spawning grounds near any of the proposed watercourse crossings.

Disturbance/displacement during construction is not predicted to affect the conservation status of the local fish populations and therefore, will not result in a likely significant negative effect, at any geographic scale.

Habitat Severance/Barrier Effect

Instream construction works have the potential to sever fisheries habitat and result in a barrier to fish passage, at least temporarily. Restricting fish access to food resources, or spawning grounds, could have long-term effects on the local fish populations.

The habitat affected by, and upstream of, the proposed road development in the catchments of Sruthán na Líbeirtí, the Trusky Stream, the Bearna Stream (and tributary), the Tonabrocky Stream, and the Knocknacarra Stream were considered to be of a low fisheries value – most being seasonal in nature with few, or no, fish species recorded during the fisheries surveys. Therefore, any temporary severance or barrier effect during construction is not likely to result in long-term effects on the local fish populations in these catchments.

As the proposed River Corrib Bridge is a clear span bridge structure with no instream structures or works with the potential to block the river channel, no habitat severance or barrier effect will occur on the River Corrib.

Overall, habitat severance and barrier effect during construction is not likely to have any long-term effect on the local fish populations or their conservation status, and therefore will not result in a likely significant negative effect, at any geographic scale.

8.5.11.2 Operation Phase Impacts

Habitat Degradation – Surface Water

There will be drainage outfalls to all river/stream catchments crossed by the proposed road development. Therefore, there is a risk that discharges from the proposed road drainage network could affect water quality, potentially over the long-term, and consequently impact upon aquatic habitats and fish species. In a worst-case-scenario, this could result in a permanent decline in fish species abundance and distribution.

The proposed drainage design for the mainline of the proposed road development incorporates pollution control measures (this includes petrol interceptors, wetland and other measures, such as SuDS) followed by either infiltration ponds (where discharging to ground) or attenuation ponds (where drainage will be discharged to the existing surface water/storm sewer), as described in detail in **Chapter 5, Description of Proposed Road Development**.

Those sections of the proposed road drainage that are to be discharged to ground, pose no risk to surface water quality. It is extremely unlikely that the normal operating water quality of the drainage outfalls discharging to the existing surface water/drainage network, even in the unlikely event of a pollution incident, would have any perceptible long-term effect on water quality in receiving watercourses. The functioning and effectiveness of both elements of the proposed road drainage network are discussed in more detail in the hydrology chapter (**Chapter 11, Hydrology**).

Habitat degradation because of effects on surface water or groundwater during operation is not predicted to affect the conservation status of fish species and will therefore, not result in a likely significant negative effect, at any geographic scale.

Habitat Severance/Barrier Effect

The structures have been designed in consultation with IFI and the design criteria set out in *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes* (National Roads Authority, 2005) and the *Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters* (IFI, 2016). This will maintain fish passage during the operation of the proposed road development and therefore, will result in a neutral impact to fish species.

8.5.12 Local Biodiversity Areas

The Coast Road (R336) to the N59 Moycullen Road (which includes the Cappagh – Ballymoneen and the Ballagh – Barnacranny Hill local biodiversity areas from the draft Galway City Biodiversity Action Plan 2014-2024)

In terms of biodiversity effects, the proposed road development will result in habitat loss across this area, including the loss of areas of the Annex I habitats Wet heath, Dry heath and Molinia meadow (see **Section 8.5.4** above for habitat impacts). It will also impact upon mammal species including Otter and Badger (see **Section 8.5.6** above), bat species (see **Section 8.5.6.2** above), the Marsh fritillary butterfly (see **Section 8.5.7.4**), breeding and wintering birds (see **Section 8.5.8** above), the Common frog and Smooth newt (see **Section 8.5.9**), the Common lizard (see **Section 8.5.10** above), and fish species in Sruthán na Líbeirtí, the Trusky Stream, the Bearna Stream, the Tonabrocky Stream and the Knocknacarra Stream (see **Section 8.5.11** above).

Rusheen Bay – Barna Woods – Illaunafamona

The proposed road development has the potential to affect habitats and species in Rusheen Bay if it were to result in a deterioration in water quality in the receiving surface water network, which discharges to Rusheen Bay (the Bearna Stream, the Tonabrocky Stream and the Knocknacarra Stream). For example, this is discussed above in **Section 8.5.4.1** in relation to habitats (including watercourses), in **Section 8.5.6.1.1** in relation to Otter, and in **Section 8.5.8.2.1** in relation to wintering birds. The proposed road development also has the potential to present a barrier to Otter movement in watercourses connected to Rusheen Bay (features that are important in supporting the local Otter populations), and road traffic has the potential to present a mortality risk to Otter (see **Section 8.5.6.1** above).

The River Corrib and the Coolagh lakes (which includes the River Corrib and adjoining wetlands local biodiversity areas from the draft Galway City Biodiversity Action Plan 2014-2024)

In terms of biodiversity effects, the proposed road development will result in habitat loss in the vicinity of the proposed River Corrib crossing, has the potential to affect water quality in the receiving environment, has the potential to affect groundwater quality and quantity supplying the Coolagh Lakes, to disturb species using the River Corrib corridor and the Coolagh Lakes (e.g. aquatic species and breeding/wintering birds). These impacts have the potential to affect both habitats and the assemblage of fauna species supported by those habitats; which include Otter, fish species, wintering and breeding birds, bats (including the Lesser horseshoe bat) and mollusc species. Construction of the River Corrib Bridge has the potential to affect aquatic species through the risk of construction materials dropping into the river, with operation of the proposed road development posing a mortality risk to Otter.

The effects on the River Corrib and the Coolagh Lakes are discussed briefly in **Section 8.5.3.1** in relation to Lough Corrib cSAC and in Section **8.5.3.2.2** in relation to Lough Corrib pNHA. However, a more detailed assessment is presented in the NIS in the context of impacts on the River Corrib/Coolagh Lakes and Lough Corrib cSAC, which considers all of the aforementioned potential impacts, as the cSAC designation includes the River Corrib and the Coolagh Lakes. This area is also included within the Lough Corrib pNHA.

Menlough to Coolough Hill (including Lackagh Quarry)

In terms of biodiversity effects, the proposed road development will result in habitat loss across this area, including semi-natural grasslands, woodland, scrub, calcareous springs and exposed limestone rock – this includes the loss of areas of the Annex I habitats Petrifying springs, Limestone pavements, Calcareous grasslands and Residual alluvial forests. There is also the potential for groundwater impacts to affect a Turlough feature (see **Section 8.5.4** above for habitat impacts). It will also impact upon mammal species including Badger (see **Section 8.5.6** above), bat species (and in particular the Lesser horseshoe bat and the maternity roost at Menlo Castle, see **Section 8.5.6.2** above), breeding birds (including Barn owl, see **Section 8.5.8** above), and potentially amphibian species (see **Section 8.5.9**).

A portion of this area also lies within Lough Corrib cSAC, this is discussed briefly in **Section 8.5.3.1** in relation to Lough Corrib cSAC. However, a more detailed assessment is presented in the NIS in the context of impacts on that portion of this area that lies within Lough Corrib cSAC

Ballindooley – Castlegar (which is linked to the River Corrib by the Terryland River valley)

In terms of biodiversity effects, the proposed road development will result in habitat loss at Ballindooley Lough, including the loss of an area of *Molinia* meadow, and also has the potential to affect surface water quality in the lakes during construction (see **Section 8.5.4** above for habitat impacts). These impacts will also likely impact upon mammal species generally (see **Section 8.5.6** above), bat species including the Lesser horseshoe bat (see **Section 8.5.6.2** above), breeding and wintering birds (see **Section 8.5.8** above), fish species in the lakes (see **Section 8.5.11** above), and potentially amphibian species (see **Section 8.5.9**).

Galway Racecourse, Ballybrit

The semi-natural habitats present at this site are not directly impacted or likely to be affected in any way by the proposed road development.

Doughiska

In terms of biodiversity effects, the proposed road development will result in habitat loss within this area, including the loss of areas of the Annex I habitats Calcareous grassland and Limestone pavement (see **Section 8.5.4** above for habitat impacts). It is also likely to impact upon mammal species generally (see **Section 8.5.6** above), bat species (see **Section 8.5.6.2** above) and breeding and wintering birds (see **Section 8.5.8** above).

Galway Bay (which includes the Mutton Island and Nearby Shoreline local biodiversity areas from the draft Galway City Biodiversity Action Plan 2014-2024)

The proposed road development has the potential to affect habitats and species in Galway Bay if it were to result in a deterioration in water quality in the receiving surface water network, which discharges to Galway Bay. The proposed road development also has the potential to present a barrier to Otter movement in watercourses connected to Galway Bay (features that are important in supporting the local Otter populations), and road traffic has the potential to present a mortality risk to Otter.

8.5.13 Summary of Potential Impacts

Table 8.34 below presents an overall summary of the likely significant effects of the proposed road development on biodiversity, in the absence of mitigation measures.

Table 8.34: Summary of Likely Significant Effects of the Proposed Road Development on Biodiversity (pre-mitigation)

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance
Designated Areas for Nature Conservation			
Lough Corrib cSAC (including Lough Corrib pNHA)	International (National)	**Construction** Habitat loss Habitat degradation – tunnelling/excavation Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance
		Habitat degradation – hydrology Habitat degradation – air quality Habitat degradation – non-native invasive plant species Mortality risk **Operation** Habitat degradation – hydrogeology Habitat degradation – non-native invasive plant species Mortality risk	
Galway Bay Complex cSAC (including Galway bay Complex pNHA)	International (National)	**Construction** Habitat degradation – hydrology Habitat degradation – non-native invasive plant species Barrier effect Mortality risk	Likely significant effect at the international geographic scale
Lough Corrib SPA (including Lough Corrib pNHA)	International (National)	**Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology Disturbance/displacement **Operation** Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale
Inner Galway Bay SPA including Galway bay Complex pNHA)	International (National)	**Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology Disturbance/displacement **Operation** Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale
Moycullen Bogs NHA	National	**Construction** Habitat degradation – air quality Habitat degradation – non-native invasive plant species Habitat degradation – hydrology **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale
Habitats (outside of designated areas for nature conservation)			
Limestone pavement [*8240]	International Importance	**Construction** Habitat loss Habitat degradation – air quality	Likely significant effect at the international geographic scale

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance
		Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	
Petrifying springs [*7220]	International Importance	**Construction** Habitat loss	Likely significant effect at the county geographic scale (see **Section 8.5.4.3** under petrifying springs)
Calcareous grassland [*6210/6210]	International/ National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale (No *6210 affected – see **Section 8.5.4.3** under Calcareous grassland))
Dry heath [4030]	National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale
Wet heath [4010][80]	National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – groundwater **Operation** Habitat degradation – groundwater	Likely significant effect at the national geographic scale
Molinia meadow [6410]	National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale

[80] Including areas of Wet heath/Dry heath/*Molinia* meadow [4010/4030/6410] mosaic

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance
Residual alluvial forest [*91E0]	International Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the international geographic scale
Turloughs [*3180]	International Importance	**Construction** Habitat loss Habitat degradation – surface water quality Habitat degradation – groundwater Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – groundwater Habitat degradation – non-native invasive plant species	Likely significant effect at the international geographic scale
Hard water lakes [3140]	National Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the national geographic scale
Mesotrophic lakes (FL4) *Part of Ballindooley complex*	County Importance[81]	**Construction** Habitat degradation – surface water quality	Likely significant effect at the county geographic scale
Eutrophic lakes (FL5) *Part of Ballindooley complex*	County Importance[82]	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the county geographic scale
Calcareous springs (FP1) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss	Likely significant effect at the local geographic scale
Cladium fen [*7210]	International Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the international geographic scale

[81] On the basis that it forms part of the wetland complex at Ballindooley Lough
[82] On the basis that it forms part of the wetland complex at Ballindooley Lough

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance
Hydrophilous tall herb [6430]	International Importance	(see Lough Corrib cSAC above) **Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology **Operation** Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale
Alkaline fens [7230]	National Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the national geographic scale
Reed and large sedge swamps (FS1) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality	Likely significant effect at the local geographic scale
Tall-herb swamps (FS2) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale
Eroding/upland rivers (FW1)	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality	Likely significant effect at the local geographic scale
Depositing /lowland rivers (FW2) River Corrib	International Importance	The River Corrib forms part of see Lough Corrib cSAC (see above and NIS)	Likely significant effect at the international geographic scale
Terryland River	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale
Drainage ditches (FW4)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale
Marsh (GM1)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale
Dry calcareous and neutral grassland (GS1) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance
Dry meadows and grassy verges (GS2) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale
Dry-humid acid grassland (GS3) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale
Wet grassland (GS4) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale
Rich fen and flush (PF1) Non-Annex I habitat type	County Importance	**Construction** Habitat degradation – surface water quality Habitat degradation – air quality	Likely significant effect at the county geographic scale
Poor fen and flush (PF2) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality **Operation** Habitat degradation – groundwater	Likely significant effect at the local geographic scale
(Mixed) broadleaved woodland (WD1)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale
Mixed broadleaved/conifer woodland (WD2)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale
(Mixed) conifer woodland (WD3)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance
Hedgerows (WL1)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale
Treelines (WL2)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale
Oak-ash-hazel woodland (WN2) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat degradation – air quality Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale
Scrub (WS1) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale
Fauna Species			
Badger	Local Importance (Higher Value)	**Construction** Loss of breeding/resting sites Disturbance/displacement **Operation** Habitat severance/barrier effect Mortality risk	Likely significant effect at the local geographic scale
Otter	International Importance	**Construction** Habitat degradation - water quality **Operation** Habitat severance/barrier effect Mortality risk	Likely significant effect at the local geographic scale
Other mammal species protected under the Wildlife Acts	Local Importance (Higher Value)	**Construction** Habitat degradation - water quality **Operation** Habitat severance/barrier effect	Likely significant effect at the local geographic scale

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance
		Mortality risk	
Lesser horseshoe bat	National Importance	**Construction** Roost loss Habitat loss Habitat fragmentation Disturbance/displacement **Operation** Mortality Barrier/severance effects Disturbance/displacement	Likely significant effect at the national geographic scale
All other bat species	Local Importance (Higher Value)		Likely significant effect at the local geographic scale
Marsh whorl snail	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater **Operation** Habitat degradation – groundwater	Likely significant effect at the local geographic scale
Marsh fritillary butterfly	County Importance	**Construction** Mortality risk	Likely significant effect at the local geographic scale
SCI bird species	International	*see Lough Corrib SPA and Inner Galway Bay SPA above*	*see Lough Corrib SPA and Inner Galway Bay SPA above*
Barn owl	County Importance	**Operation** Mortality risk	Likely significant effect at the county geographic scale
Peregrine falcon	County Importance	**Construction** Disturbance/displacement **Operation** Disturbance/displacement	Likely significant effect at the county geographic scale
All other breeding bird species (non SCI)	Local Importance (Higher Value)	**Construction** Mortality risk Disturbance/displacement **Operation** Mortality risk Disturbance/displacement	Likely significant effect at the local geographic scale
All other wintering bird species (non-SCI)	Local Importance (Higher Value)	**Construction** Disturbance/displacement (Ballindooley Lough) Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance
Smooth newt Common frog	Local Importance (Higher Value)	**Construction** Habitat loss Disturbance & mortality risk Habitat degradation – surface water quality **Operation** Habitat severance/barrier effect	Likely significant effect at the local geographic scale
Common lizard	Local Importance (Higher Value)	**Construction** Habitat loss Disturbance & mortality risk **Operation** Habitat severance/barrier effect	Likely significant effect at the local geographic scale
Atlantic salmon European eel	International Importance	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale
All other fish species recorded	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale
Local Biodiversity Areas			
Local biodiversity areas	The value of the biodiversity receptors recorded in the vicinity of the proposed road development, across the local biodiversity areas, range from Local Importance (Lower Value) to Internationally Important	Combinations of all of the potential impacts noted above. The specific impacts are related to and dependent upon the potential impacts of the proposed road development on each of the individual ecological receptors that make up the biodiversity resource within a given local biodiversity area	Likely significant effects from local up to the international geographic scale

8.6 Mitigation Measures

This section presents the mitigation measures to avoid or reduce the potential impacts of the proposed road development on biodiversity. **Section 8.6.1.1** summarises the mitigation measures that relate to the protection of European sites. All other mitigation measures are described in **Sections 8.6.2** to **8.6.12** below. All of these mitigation measures are included in the Schedule of Environmental Commitments which will be implemented by the contractor under supervision of both the Project Ecologist (employed by the Employer) and the Ecological Clerk of Works (employed by the Contractor).

8.6.1 Designated Areas for Nature Conservation

8.6.1.1 European Sites

The mitigation measures that are specifically required to ensure that the proposed road development will not result in a likely significant effect (i.e. adversely affect the integrity of) on the European sites within its ZoI (Lough Corrib cSAC, Lough Corrib SPA, Galway Bay Complex cSAC and Inner Galway Bay SPA) are presented in Section 10 of the NIS. Following a consideration and assessment of the proposed road development on the identified relevant European sites, mitigation measures were developed to address the following potential impacts that were identified:

- Habitat loss/fragmentation: mitigation measures to minimise habitat loss in Lough Corrib cSAC and to avoid loss of QI habitats within Lough Corrib cSAC during construction
- Habitat degradation – tunnelling/excavation: mitigation measures to maintain the structural integrity of rock mass supporting QI habitats in Lough Corrib cSAC during the construction of the proposed Lackagh Tunnel (and its western approach)
- Habitat degradation – hydrogeology: mitigation measures to avoid habitat degradation in Lough Corrib cSAC as a result of potential hydrogeological impacts during construction and operation
- Habitat degradation – hydrology: mitigation measures to protect water quality in receiving watercourses during construction
- Habitat degradation – air quality: mitigation measures to control dust emissions during construction to prevent impacts on vegetation in Lough Corrib cSAC
- Habitat degradation – non-native invasive plant species: mitigation measures to avoid the introduction or spread of non-native plant invasive species to European sites during construction or operation
- Disturbance/displacement: mitigation measures to avoid/reduce the disturbance/displacement effects of blasting on wintering birds using Ballindooley Lough
- Barrier effect: mitigation measures to avoid the proposed road development restricting Otter movement within the Bearna Stream catchment

- Mortality risk: mitigation measures to avoid mortality of the QI species of Lough Corrib cSAC. These include both measures to ensure that construction materials are not introduced into the River Corrib and to remove the risk of Otter being killed/injured due to collisions with road traffic

8.6.1.2 Natural Heritage Areas and proposed Natural Heritage Areas

As discussed in **Section 8.5.3.2**, the potential for the proposed road development to significantly affect Lough Corrib pNHA or Galway Bay Complex pNHA is as per the corresponding European sites (Lough Corrib cSAC and Lough Corrib SPA in relation to Lough Corrib pNHA, and Galway Bay Complex cSAC and Inner Galway Bay SPA in relation to Galway Bay Complex pNHA). Therefore, the mitigation measures outlined above in **Section 8.6.1.1**, and as detailed in Section 10 of the NIS, will prevent the proposed road development resulting in a significant negative effect on Lough Corrib pNHA or Galway Bay Complex pNHA at the national geographic scale.

The mitigation measures that are required to ensure that the proposed road development will not significantly affect Moycullen Bogs NHA are as follows:

- Measures to control dust emissions during construction to prevent impacts to vegetation/habitats within Moycullen Bogs NHA at Tonabrocky – see **Section 8.6.2** below and **Chapter 16, Air Quality and Climate**. These include control measures such as spraying of exposed earthwork activities and site haul roads during dry weather, wheel washes, control of site vehicle speeds, road sweeping and dust screens
- Measures to avoid the introduction or spread of non-native invasive plant species to Moycullen Bogs NHA during construction or operation. These are detailed in the Non-native Invasive Species Management Plan which forms part of the Construction Environmental Management Plan (CEMP) – (**Appendix A.7.5**)
- Measures to control surface water runoff from the construction site to prevent an accidental pollution event affecting peatland habitats within Moycullen Bogs NHA at Tonabrocky – see **Section 11.6.2** of **Chapter 11, Hydrology**

8.6.2 Habitats

8.6.2.1 Mitigation Measures to Minimise Habitat Loss

To minimise the loss of Annex I habitat, areas of these habitat types within the proposed development boundary but which are not required to construct the proposed road development will be retained and fenced off for the duration of construction. These areas will also not be directly impacted during the operation of the proposed road development. These are shown on **Figures 8.23.1** to **8.23.14**.

To minimise the loss of habitat associated with the proposed road development, there are also areas within the proposed development boundary which are included for mitigation planting where general construction works will not be undertaken. These are shown on **Figures 8.23.1** to **8.23.15**.

Where possible, woodland, scrub, treelines and hedgerows which lie within, or along the boundary of the proposed road development, that are not directly impacted by the proposed road alignment or drainage will be retained. These areas will be protected for the duration of construction works and fenced off at an appropriate distance. Vegetation to be retained is shown on **Figures 8.23.1** to **8.23.15** and on **Figures 12.2.01** to **12.2.15**.

Where possible, areas of river channel and bankside vegetation which lie within, or along the boundary of the proposed road development, that are not directly impacted by the proposed road alignment or drainage will be retained. These areas will be protected for the duration of construction works and fenced off at a distance of 5m from the stream/river bank.

The Petrifying spring feature present in Lackagh Quarry, which lies c.25m to the north of the mainline of the proposed road development at Ch. 11+400, will be retained and shotcrete[83] will not be used as part of the quarry face stabilisation measures at the spring site.

8.6.2.2 Measures to Reduce the Potential for Impacts on Vegetation to be retained

Any vegetation (including trees, hedgerows or scrub adjacent to, or within, the proposed development boundary) which is to be retained shall be afforded adequate protection during the construction phase in accordance with the Guidelines for the Protection and Preservation of Trees, Hedgerows and Scrub Prior to, During and Post Construction of National Road Schemes (National Roads Authority, 2006b), as follows:

- All trees along the proposed development boundary that are to be retained, both within and adjacent to the proposed development boundary (where the root protection area of the tree extends into the proposed development boundary), will be fenced off at the outset of works and for the duration of construction to avoid structural damage to the trunk, branches or root systems of the trees. Temporary fencing will be erected at a sufficient distance from the tree so as to enclose the Root Protection Area (RPA) of the tree. The RPA will be defined based upon the recommendation of a qualified arborist
- Where fencing is not feasible due to insufficient space, protection for the tree/hedgerow will be afforded by wrapping hessian sacking (or suitable equivalent) around the trunk of the tree and strapping stout buffer timbers around it
- The area within the RPA will not be used for vehicle parking or the storage of materials (including soils, oils and chemicals). The storage of hazardous

[83] A concrete product which is sprayed at high velocity into a rock face as a structural/stabilising component.

materials (e.g. hydrocarbons) or concrete washout areas will not be undertaken within 10 m of any retained trees, hedgerows and treelines

- A qualified arborist shall assess the condition of, and advise on any repair works necessary to, any trees which are to be retained or that lie outside of the proposed development boundary but whose RPA is impacted by the works. Any remedial works required will be carried out by a qualified arborist
- A buffer zone of at least 5m will be maintained between construction works and retained hedgerows to ensure that the root protection areas are not damaged

8.6.3 Measures to Reduce the Potential for Air Quality Impacts during Construction

To control dust emissions during construction works standard mitigation measures shall include: spraying of exposed earthwork activities and site haul roads during dry and/or windy conditions; provision of wheel washes at exit points; control of vehicle speeds and speed restrictions (20km/h on any un-surfaced site road); covering of haulage vehicles; and, sweeping of hard surface roads. These procedures will be strictly monitored and assessed on a daily basis.

Dust screens will be implemented at locations where there is the potential for air quality impacts during the construction phase i.e. at locations where sensitive receptors are located within 100m of the works. In addition, a 2m dust screen will be provided at the locations in the areas of the overlap of the proposed road development and the Lough Corrib cSAC and adjacent to Moycullen Bogs NHA.

These measures are detailed further in **Section 16.6.2** of **Chapter 16, Air Quality and Climate** and in the CEMP in **Appendix A.7.5**.

8.6.4 Mitigation Measures to Reduce the Potential for Impacts to Water Quality in Receiving Watercourses

The mitigation measures to protect surface water during construction are detailed in **Section 11.6.2** of **Chapter 11, Hydrology**.

As is normal practice the Construction Environmental Management Plan (CEMP) included in **Appendix A.7.5** will be finalised by the Contractor in advance of the commencement of construction and the following will be implemented as part this plan:

- An Incident Response Plan detailing the procedures to be undertaken in the event of spillage of chemical, fuel or other hazardous wastes, logging of non-compliance incidents and any such risks that could lead to a pollution incident, including flood risks (Refer to Section 10 of the CEMP in **Appendix A.7.5**)
- A Sediment Erosion and Pollution Control Plan (Refer to Section 8 of the CEMP in **Appendix A.7.5**). This shall include water quality monitoring and method statements to ensure compliance with environmental quality standards specified in the relevant legislation (i.e. surface water regulations and Salmonid Regulations 1988)

Refer to Section **11.6.2** of **Chapter 11, Hydrology** for further mitigation measure details.

8.6.5 Measures to Protect Groundwater Quantity and Groundwater Quality

The mitigation measures to protect groundwater quantity and quality during construction and operation are detailed in **Section 10.6.2** (construction) and **Section 10.6.3** (operation) of **Chapter 10, Hydrogeology**.

Mitigation measures are included in **Section 9.6** of **Chapter 9, Soils and Geology** to restrict the use of fill material in areas where there is the potential for run off/infiltration to affect pH levels in adjoining peatland habitats within the operational hydrogeological ZoI.

8.6.6 Measures to Control and Prevent the Spread of Non-native Invasive Plant Species

The mitigation strategy in relation to non-native invasive plant species is based on the *Guidelines on the Management of Noxious Weeds and Non-native Invasive Plant Species on National Roads* (National Roads Authority, 2010) with the objectives of managing non-native invasive plant species within the working area and preventing the spread of any established populations present with the boundary of the proposed road development (a legal requirement for species such as Japanese knotweed).

A Non-native Invasive Species Management Plan has been prepared and included in the CEMP (see **Appendix A.7.5**) and will be implemented sufficiently far in advance of the proposed construction works commencing so as to allow time to adequately control all target non-native invasive plant species populations within the ZoI of the proposed road development, having regard to the specific timing/seasonal constraints that apply in relation to each individual species. The Non-native Invasive Species Management Plan will direct the construction contractor in implementing the specific mitigation measures required in relation to individual non-native invasive plant species.

As species may have spread, or their distribution may have changed, between the habitat surveys carried out for this EIAR and the commencement of construction works, the implementation of the Non-native Invasive Species Management Plan will include a pre-construction re-survey within the proposed development boundary. In accordance with the NRA guidance this survey will include accurate 1:5,000 scale mapping for the precise location of non-native invasive plant species. The pre-construction surveys will be undertaken by suitable experts with competence in identifying the species concerned.

In accordance with the National Roads Authority, 2010a guidelines, where cut, pulled or mown noxious weed or non-native invasive plant species material arises, its disposal will not lead to a risk of further spread of the plants. Care will be taken near watercourses as water is a fast medium for the dispersal of plant fragments and seeds. Material that contains flower heads or seeds will be disposed of either by composting or burial at a depth of no less than 0.5m in the case of noxious weeds, or by incineration (at a licenced facility having regard to relevant legislation) or disposal to licensed landfill in the case of non-native invasive plant species.

The taproots of docks and roots of creeping thistle are not suitable for composting or shallow burial, requiring disposal to landfill, incineration or burying at a depth of no less than 1.5m (practical only during the construction phase). Where burial is being used to dispose of Japanese knotweed, the material will be buried to a depth of 5m and overlain with a suitable geotextile membrane. All disposals will be carried out in accordance with the Waste Management Acts 1996-2011.

In relation to aquatic non-native invasive plant species all construction works, and any aquatic survey work that may be carried out (e.g. electrofishing), will comply with best practice biosecurity protocols for aquatic work – for example IFI's Biosecurity Protocol for Field Survey Work (IFI, 2010).

8.6.7 Mammals

8.6.7.1 Otter

Otter are listed on Annex II and Annex IV of the EU Habitats Directive. Otter are strictly protected under the Birds and Habitats Regulations. Otter, and their breeding and resting places, are also protected under the Wildlife Acts and it is an offence under that legislation to intentionally kill or injure an Otter or to wilfully interfere with or destroy their breeding or resting places (holts/couches).

8.6.7.1.1 Measures to Protect Otter during Construction

Habitat degradation - water quality

The mitigation measures relating to the protection of water quality in receiving watercourses during construction are outlined in **Section 8.6.4** and detailed in **Section 11.6.2** of **Chapter 11, Hydrology**.

Loss of breeding/resting sites

As in the future Otter could potentially establish new holt or couch sites within the ZoI of the proposed road development, a pre-construction check of all suitable Otter habitat will be required within 12 months of any constructions works commencing.

8.6.7.1.2 Measures to Protect Otter during Operation

Habitat Severance/Barrier Effect and Collision Risk

Otters use many of the watercourses crossed by the proposed road development. To avoid Otter road casualties, Otter passage facilities will be provided at all watercourses used by Otter (e.g. raised ledges within structures, or separate dry 600mm pipes installed adjacent to culverts). Mammal underpasses will be constructed in accordance with the *Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes* (National Roads Authority, 2008c).

The locations where Otter passage facilities will be provided are listed below in **Table 8.36** and are shown on **Figures 8.23.1** to **8.23.14**.

Mammal-resistant fencing will be required to prevent Otter accessing the proposed road development and to guide Otters to the mammal underpasses. Mammal-resistant fencing will be installed in accordance with the specification outlined in *Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes* (National Roads Authority, 2008c) and TIIs mammal resistant fencing specification (currently CC-SCD-00320/00319). The locations where mammal-resistant fencing is to be installed are shown on **Figures 8.23.1** to **8.23.14**.

In accordance with the recommendations described in the *Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes* (National Roads Authority, 2008c), quarterly monitoring of the effectiveness of the mitigation measures will be undertaken in the first year after the completion of construction works (for example, fencing inspections to check for gaps and underpass inspection to check for blockages).

8.6.7.2 Bats

Bats are listed on Annex IV of the EU Habitats Directive and are therefore, strictly protected under the Birds and Habitats Regulations. Bats, and their breeding and resting places, are also protected under the Wildlife Acts and it is an offence under that legislation to intentionally kill or injure bats or to wilfully interfere with or destroy their breeding or resting places.

8.6.7.2.1 Measures to Protect Bats during Construction

Measures to Protect Bats during removal of Roosts

This assessment has identified that 14 properties that are confirmed bat roosts may be required to be removed as part of the proposed road development. A further 18 properties may be indirectly affected due to their proximity to the corridor or the proposed road development or are connected via known flight paths and in some cases disturbance to the roost may result.

All species and their roost sites are strictly protected under both European and Irish legislation including:

- Wildlife Act 1976 and Wildlife (Amendment) Act, 2000 (S.I. No. 38 of 2000)
- Council Directive on the Conservation of Natural Habitats and of Wild Flora and Fauna 1992 (Council Directive 92/43/EEC)
- European Communities (Birds and Natural Habitats) Regulations, 2011

It is an offence under Section 23 of the Wildlife Acts 1976-2017 and under Section 51 of the European Communities (Birds and Natural Habitats) Regulations, 2011 to kill a bat or to damage or destroy the breeding or resting place of any bat species. Under the European Communities (Birds and Natural Habitats) Regulations it is not necessary that the action should be deliberate for on offence to occur. This places an onus of due diligence on anyone proposing to carry out works that might result in such damage or destruction. Under Section 54 of S.I. 477 of 2011, a derogation may be granted by the Minister where there is no satisfactory alternative and the derogation is not detrimental to the maintenance of the populations of the species to which the Habitats Directive relates at a favourable conservation status in their natural range. Given the impacts on bats that are predicted for the proposed road development, a derogation licence under Section 54 of S.I. 477 of 2011 will be required. The Bat Derogation Licence application is included in **Appendix A.8.25**.

The following mitigation measures are proposed in relation to structures either confirmed as supporting bat roosts or considered to have the potential to support roosting bats:

- Prior to demolition of the 14 structures containing confirmed bat roosts, replacement artificial roosts will be in place to ensure that bats are able to access alternative resting places at the earliest opportunity
- Where possible, buildings with the confirmed bat roosts will not be demolished during the breeding period or hibernation period (April to mid-August and November-March) as the risk of accidental death or injury is higher at this time. Bats may use roosts in smaller numbers in winter but may nevertheless be present. Outside of these periods, the approach to demolition of bat roosts will be determined on a case-by-case basis and subject to relevant licence conditions
- Buildings confirmed as bat roosts proposed for demolition will be marked on the ground with agreed paint marking to permit identification by Contractors
- Prior to demolitions, all structures that were confirmed as either having bats or having high potential for bats will be re-examined immediately prior to demolition to assess whether bats are present at the time of demolition. This will be an all-night examination to determine if bats enter the building during the night or early morning. This will provide adequate information to proceed with demolitions unless weather conditions were unsuitable for feeding bats. If bats are present, then they will require exclusion from the property over several nights or if possible physical removal by hand by a licenced bat specialist to be placed in a bat box or similar for release in the evening after capture. For structures which have not been confirmed as bat roosts but regarded to have high potential for bats, a bat detector assessment of the property to be demolished will be carried out. If demolitions are proposed during the period May – August (note this time period will not be permitted in the case of the confirmed bat roosts to be demolished). This will be an all-night examination to determine if bats enter the building during the night or early morning. This will provide adequate information to proceed with demolition unless weather conditions were unsuitable for feeding bats. If bats are present, then they will require exclusion from the property over several nights or if possible physical removal by hand by a licenced bat specialist to be placed in a bat box or similar for release in the evening after capture
- Once structures containing roosts are deemed to be clear of bats, the bat specialist will be on site to supervise the demolition procedure until the structure is no longer deemed able to support a bat roost. Bats may re-enter a partially demolished structure overnight so the bat specialist may be required to be present during demolition works until they are completed

The following mitigation measures are proposed in relation to those trees identified as having high potential to support roosting bats. These include the two trees confirmed to have had bats present (PTR43, PTR48) or the 13 other trees to have high suitability, where either obvious potential roosting features are present, or where obscured by dense ivy cover, the tree is of an age and condition that there is a high chance that roosting features are present. **Figures 8.16.1** to **8.16.15** shows the locations of these trees but a more detailed drawing will be provided to the contractor prior to any felling works. Bats could occupy suitable roosting features at any time prior to the commencement of works. Therefore there is an inherent risk that bats could be affected by the proposed felling works. The following mitigation procedures will be followed:

- Felling of confirmed and potential tree roosts will be undertaken during the period September – October as during this period bats are capable of flight and may avoid the risks from tree felling if proper measures are undertaken, but also are neither breeding nor in hibernation
- Use of detectors alone may not be sufficient to record bat emergence and re-entry in darkness. Therefore, prior to felling of confirmed and potential tree roosts, an emergence survey using infra-red illumination and video camera(s) and bat detectors will be carried out on the night immediately preceding the felling operation to determine if bats are present
- Where it is safe and appropriate to do so for both bats and humans, such trees may be felled using heavy plant to push over the tree. In order to ensure the optimum warning for any roosting bats that may still be present, the tree will be pushed lightly two to three times, with a pause of approximately 30 seconds between each nudge to allow bats to become active. The tree should then be pushed to the ground slowly and should remain in place until it is inspected by a bat specialist
- Trees should only be felled “in section” or “soft felled” where the sections can be rigged to avoid sudden movements or jarring of the sections
- Where remedial works (e.g. pruning of limbs) is to be undertaken to trees deemed to be suitable for bats, the affected sections of the tree will be checked by a bat specialist (using endoscope under a separate derogation licence held by that individual) for potential roost features before removal. For limbs containing potential roost features high in the tree canopy, this will necessitate the rigging and lowering of the limb to the ground (with the potential roost feature intact) for inspection by the bat specialist before it is cut up or mulched. If bats are found to be present, they will be removed by a bat specialist licenced to handle bats and released in the area in the evening following capture

Prior to felling the two confirmed tree roosts (PTR43 and PTR48) replacement bat boxes will be in place to ensure that bats are able to access alternative resting places at the earliest opportunity. The location of the bat boxes in these instances will be within the proposed development boundary but the precise height and location will be decided by the bat specialist. If any additional bat tree roosts are confirmed, and will be removed by the proposed felling works, then appropriate alternative roosting sites will be provided in the form of replacement bat boxes.

Measures to preserve flight paths across Construction areas

It has been identified that during the construction phase, the removal of woodland and hedgerows and other intervention in the landscapes used by bats can open up habitats to the extent that bats will not want to risk crossing the new open space to reach other roosts and foraging areas on the other side. This severance of flight paths will continue throughout the construction phase.

The Report WC1060 *Development of a Cost-Effective Method for Monitoring the Effectiveness of Mitigation for Bats crossing linear infrastructure* includes best practice principles to address the general lack of evidence to show that many "conventional" mitigation measures work. These principles are reproduced below and have been adopted in the mitigation strategy for the proposed road development.

- *"Mitigation should be integrated into the scheme from the earliest opportunity*
  - *Mitigation should be considered during the planning and design stage of the infrastructure so that it can be incorporated effectively*
- *Crossing structures should be placed on the exact location of existing bat commuting routes*
  - *Attempts should not be made to divert bats from their existing commuting routes*
- *Crossing structures should not require bats to alter flight height or direction.*
  - *This will depend on the topography of the site. If the road is to be elevated above ground level an underpass may be used to preserve the commuting route below it, or if the road is in a cutting a green bridge may be used to carry the commuting route over the road*
- *Crossing structures should maintain connectivity with existing bat commuting routes*
  - *Connectivity must be maintained with undisturbed bat flight paths (e.g. treelines, hedgerows, woodland rides and streams), and bat habitat (e.g. woodland) within the surrounding landscape. Crossing structures should not be exposed or sited within open ground*
- *Over-the-road structures such as green bridges should be planted with vegetation*
  - *Vegetation should be continuous and connected (see above) and sufficiently mature before road construction (e.g. by planting either relatively mature trees or fast growing tree species in advance of construction commencing)*
- *Underpasses should be of sufficient height*
  - *Underpasses should be as spacious as possible with height being the critical factor. The minimum requirements for underpass height will be species-specific. Required heights will generally be lower for woodland-adapted species (~3 m) compared to generalist edge-adapted species (~6 m), but larger underpasses will accommodate more species.*
- *Green bridges should be of sufficient width*

  - *In addition to being vegetated, green bridges should be as wide as possible, to provide a large area for bats to commute across. Further research is needed to determine exact dimensions. We found a 30m wide green bridge to be effective in this study.*
- *Crossing structures should be unlit*
  - *The effects of light on bats are species-specific and lighting should be avoided*
- *Access and connectivity must be maintained*
  - *It is important that access to crossing structures is maintained (e.g. grilles should not be installed on underpasses) and that connecting vegetation is retained indefinitely or for as long as the mitigation structure is required*
- *Disturbance should be minimised during installation of mitigation structures*
  - *For example, by limiting noise and light pollution along the bat flight path, minimising vegetation clearance, installing suitable temporary crossing structures (which should also be subject to monitoring and evaluation), completing the installation as quickly as possible and ideally avoiding the summer months when bats are most active".*

The installation of temporary fencing across sites to replace connecting features has been used and appears to have only been monitored as part of one project in Switzerland (Britschgi et al, 2004)[84]. In this study, a 1m wide x 1.5-2m high artificial hedgerow was recorded to be followed by a proportion of the bats in a roost. It is proposed to apply similar measures in key locations to ensure that there are linear features to connect habitats across the construction footprint.

In order to inform siting of mitigation measures, including the temporary fencing described above during the construction phase, a series of infra-red/thermal camera surveys using a series of cameras and bat detectors along linear features in the following locations will be carried out in the optimum activity season. This will help to identify the preferred crossing points at the following sections:

Area 1: North of Bearna Woods

Area 2: Aughnacurra

Area 3: River Corrib to Coolough Road

Area 4: West of N84 Headford Road

Area 5: Ballindooley to Castlegar

Each area will be surveyed three times to record bats in flight in these locations with the precise vantage points for cameras to be determined during daytime surveys.

Any existing features that are identified as preferred crossing points and are scheduled for removal will be retained until the last moment and a portable artificial

[84] Britschgi A., Theiler A. & Bontadina F. (2004) *Wirkungskontrolle von Verbindungsstrukturen. Teilbericht innerhalb der Sonderuntersuchung zur Wochenstube der Kleinen Hufeisennase in Friedrichswalde-Ottendorf / Sachsen*.

crossing structure put alongside it prior to its removal, so at no stage there is a gap across the construction site at night. The use of the temporary fence as an artificial crossing structure will be monitored three times over two weeks following installation. If the artificial crossing structure is not at the same location as a proposed permanent crossing point (e.g. the wildlife overpass at Castlegar) then it shall be moved gradually over several nights to realign it with the permanent crossing point.

The nature of the artificial crossing structure may comprise lengths of camouflage netting, recycled Christmas trees roped together, portable planters or artificial plants that can be easily moved at morning and evening to ensure that the crossing is in place each night.

8.6.7.2.2 Measures to Protect Bats during Operation

Measures to reducing mortality risk and barrier effects within the design and operation of the proposed road development

The mitigation to address significant barrier effects has been designed to reflect current best practice. The last 10 years has seen an improvement in the monitoring of the effectiveness of bat mitigation measures for roads and there is considerable evidence that whilst bats may “use” measures designed to get them over or under a road, in the context of the overall population these measures may not be “effective” as they are often in the wrong place or simply not attractive to bats to use. Measuring bat mortality as a result of collisions has also been studied in greater detail in recent years.

The two main approaches employed for the proposed road development include underpasses of a suitable size where the design of the proposed road development is on embankment and a wildlife overpass where it is in cut. These two measures are the only options that have been demonstrated to be effective at a population level (CEDR, 2016, (Elmeros and Dekker, 2016, Abbot et al 2012a, 2012b).

Underpasses are proposed in important crossing point areas and are aligned with existing landscape features that are known to be used by bats as a result of the surveys. Underpasses in the Menlough - Bóthar Nua area and N84 Headford Road areas are regarded to be of critical importance for Lesser horseshoe bat and other bat movements across this landscape.

The section from the N84 Headford Road to N83 Tuam Road is almost entirely in cut and installing underpasses is not possible, therefore the only effective option is a wildlife overpass (referred to throughout this report as the Castlegar Wildlife Overpass).

The Castlegar Wildlife Overpass is a critical component of the strategy. It will allow bats to fly across the proposed road development between the roosts and foraging habitats on the north side and Coopers Cave and foraging areas to the south at this location.

From 2013-2015, bats were recorded using hedgerows at many locations in places between the N84 Headford Road and the N83 Tuam Road – a distance of 1750m. The western section of the proposed road development in this area includes for underpasses which would be used by Lesser horseshoe bats and other bat species in areas where they have been recorded, (approximately 400m in length) whilst the remainder of the proposed road development is in a cutting or it is not feasible to include such underpasses.

In the absence of the Castlegar Wildlife Overpass, it is possible that bats would attempt to cross the proposed road development at the location of the existing crossing points[85]. This would increase the risk of collisions with vehicles at this key location and for Lesser horseshoe bats this could have an adverse impact that could deplete the population to an unsustainably low level.

In the absence of the Castlegar Wildlife Overpass the Lesser horseshoe bats would not be able to use Cooper's Cave for mating in late summer and as a result they could be forced to use less suitable locations (no other mating roosts were recorded). Mating sites that are accessible to a geographically wide population and mixes of males and females from different roosts is an essential attribute to ensure genetic heterogeneity in the local bat population. At present, bats are able to get to Cooper's Cave from a variety of directions.

A potential worst case scenario barrier effect isolating the Menlo Castle roost would therefore lead to reduced genetic diversity and possible reduced reproductive rates in that population. Similarly, the bats using Cooper's Cave would be confined to sub-optimal habitats and it is not unreasonable to conclude that, in a worst-case-scenario, the cave would cease to be used by Lesser horseshoe bats.

The location of the Castlegar Wildlife Overpass is crucial to its success. Research published since 2008 by Berthinussen & Altringham (2015[86]) and evidence presented in the CEDR Safe Bat Paths reports (2016[87]) and Natural England (2015[88]) reports have identified that bats will cross a road along existing known flight paths in preference to new artificial crossings at alternative locations. Whilst this may be truer of species that are known to fly across open spaces such as Pipistrelle species, it is not known if Lesser horseshoe bats would also act in the same way. In the absence of data to the contrary the precautionary principle has been applied and the wildlife overpass has been located at known Lesser horseshoe bat crossing points. The proposed location at Ch. 12+690 – Ch. 12+720 ties in with records of Lesser horseshoe bats, Common and Soprano pipistrelle bats recorded by static bat detector in 2015. It will be essential to quantify the number of bats using each crossing point (especially the Castlegar Wildlife Overpass) immediately prior to construction in order to provide data against which post-construction surveys can be compared.

The width and design of the Castlegar Wildlife Overpass has followed simple assumptions that are based on the target species ecology and has followed best available knowledge and information as outlined below.

[85] Lighting of the proposed road development at this location may create a barrier effect, making crossing the proposed road development even more problematic for bats.
[86] *WC1060 Development of a Cost-Effective Method for Monitoring the Effectiveness of Mitigation for Bats crossing Linear Transport Infrastructure*. Final Report 2015. Anna Berthinussen & John Altringham. School of Biology, University of Leeds, Leeds LS2 9JT/
[87] http://bios.au.dk/om-instituttet/organisation/faunaoekologi/projekter/safe-bat-paths/documents/
[88] http://publications.naturalengland.org.uk/publication/6312886965108736

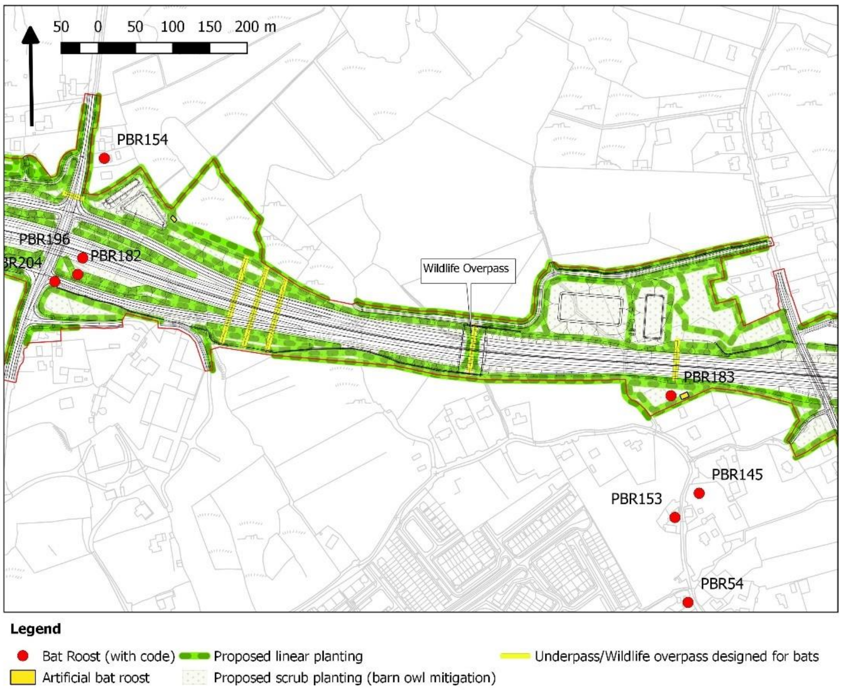
Guidance from Natural England (2015) can be summarised as follows:

- The COST 341 handbook (2003) identifies four types of 'over structure' to provide faunal passage; landscape bridges, wildlife bridges, modified bridges/ multi use bridges and tree top overpasses. A clear distinction between landscape bridges and wildlife bridges is not given, but in terms of design this appears to be based on scale aspects, with landscape bridges being larger structures over 80m wide and wildlife bridges being small in width with a recommendation of between 40 and 50m. The handbook does not use the term 'green bridge' to describe these structures
- Findings of the WC1060 Report (Berthinussen & Altringham, 2015) can be summarised as follows:
  - Although green bridges have the potential to be effective crossing structures for bats over infrastructure, there are other issues that also need to be considered such as the cost, the landtake required for construction of the bridge and the detrimental effects there may be on bats while it is being constructed. However, one expensive yet effective structure will always make more sense than cheaper structures that do not work: mitigation structures must be cost effective and functional. Green bridges may also provide mitigation for other wildlife. Eight mammal species have been found to use Scotney Castle landscape bridge, including deer, badger and breeding dormice (National Trust, 2012), and similar structures are commonly built throughout Europe and North America for large mammals. Combining mitigation for a range of wildlife may be a cost-effective solution, but would require careful planning, project management and monitoring
  - The two most widespread forms of wire bat bridge do not provide effective mitigation and should not be built, particularly since there is evidence that bats do not adapt to them with time. Our results suggest that green bridges and underpasses have the greatest potential but they must be designed correctly and many factors are important such as size, position, connectivity, topography, and the density and maturity of vegetation. Green bridges should be of sufficient width
  - Best practice principles for bat mitigation along linear transport infrastructure include that in addition to being vegetated, green bridges should be as wide as possible, to provide a large area for bats to commute across. Further research is needed to determine exact dimensions. A 30m wide green bridge was found to be effective in this study

A width below 20m is not recommended as although evidence shows that species will still use these bridges, the frequency of use is reduced. The proposed overpass bridge at Castlegar is 30m wide.

The proposed planting design comprises of a double hedgerow in the middle section of the overpass (to mimic a 4m wide bóithrín). Each of the hedgerows will then diverge out to create a "mouth" at the entrance to the overpass on both sides of the proposed road development to funnel bats in to the centre of the overpass. **Plate 8.3** shows the schematic design and location of the proposed overpass.

Plate 8.3: Castlegar Wildlife Overpass



No lighting will be provided at or on any of the structures which have been designed to provide bat passage, with the exception of S06/01 where lighting will be provided to allow for safe use by pedestrians. All of the bat underpasses (as well as artificial roosts) that are designed for Lesser horseshoe bats will have connecting woody vegetation features. Other bats species are not as reliant[89] on hedgerows and woodland edges. Whilst there are many existing landscape features outside of the proposed development boundary, the bat mitigation strategy cannot rely on these in the long term as they may be subject to interventions by third parties. In effect, what will be created is a hedgerow corridor leading up to underpasses in the section of the proposed road development between Aughnacurra and Castlegar. This planting provides a guaranteed green corridor connecting up the underpasses/overpasses and will allow bats to adapt more easily to any future landscape scale losses of connecting habitat features. The hedgerow planting leading up to underpasses will be maintained and the growth of the hedgerow monitored for 5 years following completion and remediation works undertaken if deemed necessary.

Table 8.35 below sets out the schedule of structures which provide bat passage and states the function that they serve in terms of mitigating the potential barrier effect. The size and location of the underpasses and culverts took into account the research carried out by Abbott (2012a, b) and the advice provided in the CEDR, COST341 and WC1060 reports. Design parameters included:

- Identifying where roosts are close to the proposed road development or where bat activity has been identified close to the proposed road development

[89] Although it is noted that Lesser horseshoe bats cross the River Corrib over 120m of open water at Menlo Castle.

- Identifying where the proposed vertical profile of the proposed road development (i.e. in cut, on fill or at grade) can permit bat passage underneath the proposed road development
- Where river culverts and minor roads pass under the proposed road development, it was considered if these can fulfil a role in conveying bats underneath the proposed road development
- New underpasses provided should be a minimum of 2.5m high to permit the passage of bats. Research by Abbott showed that this height would allow 90% of the bats to pass through an underpass 2.5m to 3.1m high as seen in the except from her research below

Plate 8.4: Results of surveys carried out by Abbott (2012c)

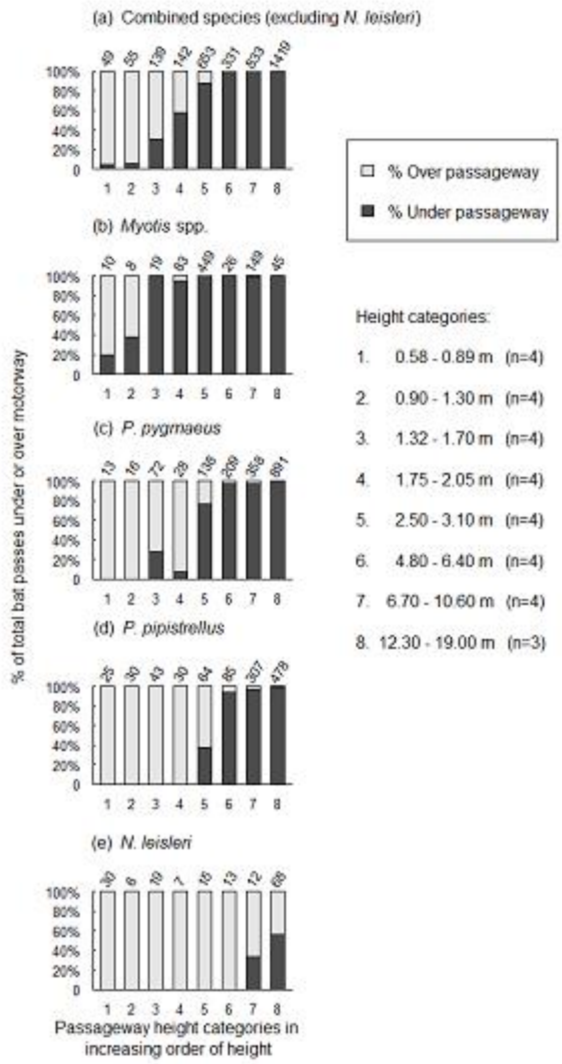


Fig. 4.17 Percentage of bat passes for **(a)** combined species (excluding *N. leisleri*), **(b)** *Myotis* spp., **(c)** *P. pygmaeus*, **(d)** *P. pipistrellus* and **(e)** *N. leisleri* (**b - e** in order of decreasing degree of clutter-adaptation) detected flying through underpasses (% Under) compared to flying over the traffic lanes of the motorway directly above underpasses (% Over) during simultaneously paired recordings. Bat pass counts (Over + Under) per height category (see legend) are shown above each bar for each species

Table 8.35: Schedule of structures designed to serve for bat passage

Structure	Description	Mitigation Function
Culvert C00/01	A 2.5m wide by 1.35m high culvert designed to provide bat passage beneath the proposed road development	Six species of bats recorded near this location. A combined hydraulic and wildlife culvert which will cater for Lesser horseshoe and Myotis species of bats which have been recorded here
Culvert C02/01b	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	A combined hydraulic and wildlife culvert which will cater for Pipistrelle species which were recorded nearby
Culvert C03/01	A 2.5m wide by 1.2m high culvert designed to provide for bat passage beneath the proposed road development	A combined hydraulic and wildlife culvert which will cater for Pipistrelle species which were recorded nearby
Culvert C03/03	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Records of Pipistrelle, Lesser horseshoe and Myotis species of bats species nearby. A combined hydraulic and wildlife culvert which will cater for bats and will also cater for the commuting route for Lesser horseshoe bats to Bearna Woods
Culvert C03/04	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Records of Pipistrelle, Lesser horseshoe and Myotis species of bats nearby. A combined hydraulic and wildlife culvert which will cater for bats and will also cater for the commuting route for Lesser horseshoe bats to Bearna Woods
Culvert C04/01	A 5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Records of Pipistrelle, Lesser horseshoe and Myotis species of bats nearby. A combined hydraulic and wildlife culvert which will cater for bats and will also cater for the commuting route for Lesser horseshoe bats to Bearna Woods.
Culvert C04/02	A 3.1m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Records of Pipistrelle, Brown long-eared and Myotis species of bats nearby. A combined hydraulic and wildlife culvert which will cater for bats
Underbridge S06/01	Proposed road underbridge	The existing Rahoon Road will allow continued bat passage underneath the proposed road development. Records of Pipistrelle species of bat nearby. There will be lighting to allow safe pedestrian access
Culvert C06/00	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Culvert will convey bats underneath proposed road development as the proposed road development severs the existing road which is used by Pipistrelle species. Records of Pipistrelle species of bat nearby, culvert

Structure	Description	Mitigation Function
		connects linear feature each side of the proposed road development
Culvert C06/01	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Culvert allows passage across proposed road development in area of fill whereas there are no areas for underpasses to the west for c.500m. Connects to attenuation ponds which may be used for foraging
Culvert C07/00	A 2.5m wide by 2m high culvert designed to provide for bat passage beneath the proposed road development	Culvert will connect across landscape used by Pipistrelle and Brown long-eared bats. Roosts to the east which will be surrounded by the proposed road development will be reconnected via this culvert and also culverts to the north
Culvert C07/02A	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Culvert will connect across landscape used by Pipistrelle and Brown long-eared bats. Roosts to the east which will be surrounded by the proposed road development will be reconnected via this culvert and also culverts to the north. The culvert carries a small stream and ties into a ditch and hedgerow on the eastern side and will join a proposed landscaped strip on the western side, to connect it to the existing Rahoon Road
Culvert C08/01A	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	This culvert is in an area of fill west of the N59 Moycullen Road and offers an opportunity for bats to cross under the proposed road development in this section. Pipistrelle and Lesser horseshoe bats have been recorded in the surrounding area
Culvert C08/05	2.5m wide by 2.5m high culverts will provide for bat passage beneath the proposed road development	These culverts are close to the artificial roost proposed to address the loss of the bat roosts at Aughnacurra (PBR178, 256, 255, 177, 210). As such it is essential to maximise permeability of the proposed road development in this section. Brown long-eared and Lesser horseshoe bats will be facilitated by this culvert. Proposed landscape planting strips will connect the culvert to retained vegetation at the perimeter
Culvert C08/04		
Culvert C08/02		
Culvert C09/01	A 5m wide by 4m high culvert will provide for bat passage beneath the proposed road development	Series of five culverts providing permeability underneath the proposed road development for Lesser horseshoe, Pipistrelle, Brown long-eared and other bat species. The culverts will open into the retained edges of Menlough woods with additional planting provided
Culvert C09/02	A 5m wide by 4m high culvert will provide for bat passage beneath the proposed road development	

Structure	Description	Mitigation Function
Culvert C09/03	A 5m wide by 4m high culvert will provide for bat passage beneath the proposed road development	
Culvert C09/04	A 5m wide by 4m high culvert will provide for bat passage beneath the proposed road development	
Culvert C09/05	A 5m wide by 4m high culvert will provide for bat passage beneath the proposed road development	
Road Underbridge S09/01	Proposed road underbridge (9.6m wide 5.3m high) Menlo Castle Bóithrín will provide for bat passage beneath the proposed road development	Key crossing point in the landscape for Lesser horseshoe bats permitting flights between Menlo Castle roost (and future new roost) and foraging areas near the Coolagh Lakes. Proven by radio-tracking data. The unlit existing road will allow continued bat passage underneath the proposed road development. Records of several species of bat nearby including being within the recorded foraging area for Lesser horseshoe bats and being in an important area for crossings
Culvert C09/06	A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development	This culvert connects woodland edges that will be retained at the edge of the culvert. Records of several species of bat nearby including being within the recorded foraging area for Lesser horseshoe bats and being in an important area for crossings
Culvert C09/07	A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development	In low area in local topography within the recorded foraging area for Lesser horseshoe bats and being in an important area for crossings
Underpass C10/01	A 18m wide by 2.35m high structure will provide for bat passage beneath the proposed road development	This structure connects woodland edges that will be retained at the edge of the culvert. Records of several species of bat nearby including being within the recorded foraging area for Lesser horseshoe bats and being in an important area for crossings as proven by radio-tracking data
Road Underbridge S10/02	Proposed road underbridge (9.6m wide by 5.3m high)	The proposed underbridge will allow continued bat passage beneath the proposed road development. Records of several species of bat nearby including Lesser horseshoe bats and being in an important area for crossings as proven by radio-tracking data

Structure	Description	Mitigation Function
Culvert C12/02	A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development	Series of 3 culverts, each 25m apart, connects lands north and south and allows bats to cross. A key crossing point for Lesser horseshoe bats, Brown long-eared bats and roosts for both species are nearby
Culvert C12/03	A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the road	
Culvert C12/04	A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the road	
Castlegar Wildlife Overbridge S12/02	The Castlegar Wildlife Overpass (60m long x 30m wide) will provide for bat passage over the proposed road development	Key crossing point in the landscape for Lesser horseshoe bats permitting flights between Castlegar and Ballindooley/Menlough areas. See text above this table for rationale for wildlife overpass location and design
Structure S08/04	River Corrib bridge will provide for bat passage over the proposed road development	An important crossing point for all bat species especially Lesser horseshoe and Daubenton's bats as proven by radio-tracking data. Roosts for both species are nearby

In addition to the structures specifically designed for bat passage, there are other structures such as where minor roads pass underneath the proposed road development which will be used by bats as safe crossing points.

8.6.7.2.3 Proposed monitoring programme

As the baseline level of bat activity and roost occupancy can change over time, pre-construction monitoring will be carried out in advance of construction works commencing to ensure that the data against which the post-construction monitoring will be compared to is as up-to-date as possible.

Monitoring of the effectiveness of the bat mitigation and compensation measures will also be undertaken during and post-construction. Where the monitoring identifies issues with either the mitigation or compensation measures (e.g. light spill affecting usage), these will be remediated to ensure that those measures will achieve their aims with respect to mitigating or compensating for impacts on the local bat populations.

Pre- construction monitoring

Pre-construction monitoring is required to provide data against which the post-construction monitoring can be compared. Parameters will include:

- Occupancy levels in roosts (Menlo Castle, proposed artificial roost buildings including retrofitted retained buildings, bat boxes)
- Bat passage structures (culverts, underpasses and the Castlegar Wildlife Overpass)

- Diversity of bat species and abundance of bat activity adjacent to the proposed road development

Occupancy levels in Menlo Castle will be measured by emergence surveys using infra-red video camera recording monthly from mid-April to September in the year of or immediately prior to construction commencing (whichever of the two is closer to the construction commencement).

Monitoring for bat usage of proposed bat passage structures will focus on recording bats using existing flight paths at proposed underpasses near Menlo Castle, the N59 Letteragh Junction and the proposed Castlegar Wildlife Overpass. Pre-construction baseline data is required on numbers of bats and flight height so that this can be compared to a post-construction scenario. Such data will be collected using focused infra-red camera and detector surveys carried out at least on three separate occasions at each location in the optimum survey period. In accordance with CEDR (2016) guidance it is proposed that this pre-construction monitoring involves a minimum of two separate surveys in the breeding season and two separate (in time) surveys in mid-August to late-September, to reflect periods of landscape-scale movements, and that these surveys take place for two bat activity seasons (May-August) following completion of the construction of the proposed road development.

The risk of adverse effects on bat diversity and abundance adjacent to the proposed road development can never be ruled out completely; but not all populations will be affected in the same location in the same way and therefore ongoing monitoring is regarded to be good practice to enhance our understanding of the effects of road developments and the effectiveness of mitigation measures. Diversity of bat species and abundance of bat activity adjacent to the proposed road development will be monitored using standardised survey transects from the edge of the proposed road development outwards as described by Berthinussen & Altringham (2015). These transects will be used to record bat activity across the lands flanking the corridor of the proposed road development. It is proposed that six transects are surveyed pre-construction in locations of high bat activity where underpasses or an overpass are proposed.

During and post-construction monitoring

<u>Roost monitoring</u>

Monitoring of occupancy of the artificial roost buildings (including retrofitted retained buildings) and bat boxes will commence immediately after their installation to determine how soon they are used. They will be installed prior to the main site clearance phase; therefore, all monitoring can be by visual inspection according to the following schedule:

- Emergence counts at Menlo Castle roost: emergence counts will be undertaken during the construction works and in 5 years following construction in May, July and August. These counts will be made using infra-red video camera recording at the same time as visual inspections of bats using the proposed new roost site adjacent to Menlo Castle in order to get an overall count of bats at this location

- Artificial roost buildings: Occupancy of the proposed artificial roost buildings (including retrofitted structures) during the works and post-construction will be undertaken in the 5 years following completion of construction. Surveys will be undertaken in mid-winter for hibernation use and in May and July for use during breeding season. Surveys will include checks for individuals and also for droppings (where necessary using DNA analysis). Droppings will be removed after each check to ensure that the subsequent survey only records usage in the interim period. The roosts will be monitored annually for Lesser horseshoe bats and counts sent to the NPWS as part of the national Lesser horseshoe bat monitoring programme. This monitoring may be undertaken by NPWS staff, Galway bat group or others to be decided by the local authority. Remote modes of monitoring using new technology may mean that visits to the roosts are not always required and that infra-red images inside the roost can be sent wirelessly. Should the monitoring of the roosts suggest that bats are not using them, additional focused surveys will be undertaken to try to understand bat movements in the locality and aim to address any issues. Any changes that may be deemed necessary will be coordinated and communicated to ensure that they do not conflict with any of the impact predictions or mitigation measures prescribed in this report. Temperature and humidity probes coupled with data loggers will be installed in the roosts for two years post construction of the roost and measures taken (e.g. fitting vents, increasing period of water tanks in the hibernation roost area) to address any issues arising
- Bat boxes: The authors are not aware of any minimum or recommended standard for bat box monitoring. After installation, boxes will be visually inspected quarterly per year for the first two years. Research into the effectiveness of mitigation measures has indicated that occupancy of bat boxes averages 50%[90] since bats may prefer existing alternative roost sites in the locality. Any boxes not showing signs of occupancy after that time may be relocated to alternative locations within the proposed development boundary nearby where they may be of benefit to the local bat population. In years 3-5 after installation the boxes will be checked in late March and September to record usage in winter and summer and to avoid disturbance during the sensitive hibernation times
- Bat boxes will be checked for a minimum of 5 years after erection

<u>Monitoring crossing points</u>

Monitoring will comprise acoustic detector and infra-red camera recording at the culverts at the five locations previously surveyed pre-construction, namely:

- Area 1: North of Bearna Woods
- Area 2: Aughnacurra
- Area 3: River Corrib to Bothár Nua
- Area 4: West of N84 Headford Road
- Area 5: Ballindooley to Castlegar, including the Castlegar Wildlife Overpass

[90] Paul Lynott, pers. comm 2017.

This will quantify the usage by bats compared to non-usage (e.g. using other flight paths). This will allow a determination as to whether the bat passage structures are being effective at a population level (where it is assumed that 90% of the bats are able to pass underneath the proposed road development). Monitoring will be repeated at all locations to provide a robust dataset. In the event that the proposed bat passage structures including the Castlegar Wildlife Overpass are not deemed to be effective, then further focused surveys will be required to determine the causes and address them in a reasonable manner where possible (for example, controlling lighting, addressing local landscape changes). Any changes that may be deemed necessary will need to be coordinated and communicated to ensure that they do not conflict with any of the impact predictions or mitigation measures prescribed in this report.

In accordance with CEDR (2016) guidance it is proposed that this post-construction monitoring involves a minimum of two separate surveys in the breeding season and two separate (in time) surveys in mid-August to late-September, to reflect periods of landscape-scale movements, and that these surveys take place for two bat activity seasons (May-August) following completion of the construction of the proposed road development.

The monitoring programme described above also relates to the compensation measures for bats described in **Section 8.9.2**.

<u>Diversity and abundance adjacent to the proposed road development corridor</u>

Transects of bat activity will be taken across the same locations as the pre-construction transects in order to identify any displacement effects caused by disturbance impacts during construction and operation. Whilst the application of the Berthinussen & Altringham (2015) methodology is not without its limitations as it has only been applied to open agricultural landscapes, it is nevertheless a foundation for a reproducible survey method that is appropriate to the proposed road development. If a displacement effect is detected (decreased abundance and diversity close to the proposed road development) then further focused surveys will be required to determine the causes and address them where possible (for example, controlling lighting, addressing local landscape changes through additional planting). Any changes that may be deemed necessary will need to be coordinated and communicated to ensure that they do not conflict with any of the impact predictions or mitigation measures prescribed in this report. It is proposed that monitoring takes place during construction and two bat activity seasons following completion of the construction of the proposed road development.

8.6.7.3 Badger

Badger, and their breeding and resting places, are protected under the Wildlife Acts and it is an offence under that legislation to intentionally kill or injure a Badger or to wilfully interfere with or destroy their breeding or resting places (setts).

A comprehensive suite of mitigation measures have been incorporated into the proposed road development to ensure that Badgers are not intentionally killed or injured and that any impacts to their breeding or resting places will not affect their conservation status, at any geographic scale, and will not give rise to any likely significant effects on the species.

The mitigation measures described below follow the recommendations set out in the *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes* (National Roads Authority, 2006). These guidelines set out the best practice approach in considering and mitigating impacts on Badgers during construction works.

8.6.7.3.1 Measures to Protect Badger during Construction

A detailed summary of the mitigation measures as they relate to each of the Badger setts within the ZoI of the proposed road development is presented in **Appendix A.8.24**. The non-interference zones (30m, 50m and 150m), as they relate to each of the Badger setts within the ZoI of the proposed road development, are shown on **Figures 8.23.1** to **8.23.14**.

As the usage of setts by Badgers can change over time, a pre-construction check of the activity status of all setts will be required within 12 months of any constructions works commencing within the ZoI of the setts discussed below.

Disturbance/displacement

In order to prevent any disturbance to Badger setts not directly affected by the proposed road development, no heavy machinery shall be used within 30m of Badger setts at any time. No works shall be under taken within 50m of active setts during the breeding season. Lighter machinery (generally wheeled vehicles) shall not be used within 20m of a sett entrance. Neither blasting nor pile driving shall be undertaken within 150m of active setts during the breeding season (December to June inclusive).

Prior to works commencing, a non-interference zone of 30m will be established around each of the Badger setts within the ZoI of the proposed road development, as shown on **Figures 8.23.1** to **8.23.14**. If the sett is active, a non-interference zone will be extended to 50m during the breeding season (December to June inclusive). The fencing shall be as noted in **Chapter 7, Construction Activities** and of a sufficient durability to maintain the exclusion zone throughout the construction period or, if required, until such time as the sett in question is excluded/removed.

The mitigation measures, as they relate to each of the Badger setts within the ZoI of the proposed road development, are summarised in **Table 8.36** and illustrated on **Figures 8.23.1** to **8.23.14**.

Loss of breeding/resting sites

Where setts require exclusion and removal, or temporary exclusion for the duration of the construction period, this will be undertaken in accordance with the methodology detailed in the *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes* (National Roads Authority, 2006):

- All Badger setts requiring exclusion and removal will require a monitoring period of at least five days to confirm activity status in advance of any construction works commencing

- If the sett is active, then it shall not be removed within the Badger breeding season (December to June inclusive). To exclude or remove an active Badger sett outside of this period, inactive entrances shall be soft and hard-blocked with one-way gates installed on active entrances. One-way gates will be tied open for three days before being set to exclude, and then monitored for a period of at least 21 days before the sett is deemed inactive and destroyed. If at any time during the monitoring period the sett becomes active, the exclusion process/programme must commence again from day 1 of the 21-day monitoring period
- For inactive setts, entrances will be soft-blocked (lightly blocked with vegetation and soil) and if all entrances remain undisturbed for a period of five days the sett should be destroyed immediately. This can be undertaken at any time of the year for inactive setts

An artificial sett is required to mitigate for the loss of the main sett (S9), in conjunction with a subsidiary sett (S11), of the Lackagh Badger group. The requirements relating to the provision and design of the artificial sett are set out in **Appendix A.8.24**. The location of the artificial sett is shown on **Figures 8.23.1** to **8.23.14**[91].

Inaccessible areas (see **Figures 8.3.1** to **8.3.14**) will require a pre-works survey for badger setts in advance of site clearance. If a sett is uncovered, works must cease and a non-interference zone of 30m established; extended to 50m during the breeding season if set is active (December to June inclusive). Sett removal will follow the process outlined above.

8.6.7.3.2 Measures to Protect Badger during Operation

Habitat Severance/Barrier Effect and Mortality Risk

Badgers typically follow the same pathways between setts, feeding areas and latrines. To avoid badger road casualties, mammal passage facilities will be provided at strategic locations along the route of the proposed road development. Mammal underpasses will be constructed in accordance with the *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes* (National Roads Authority, 2006). Mammal underpasses which are at least 600mm in width, have adequate drainage, have good vegetation cover around the entrances and good habitat connectivity have been proven to be used by badgers (Eldridge & Wynn, 2011)[92].

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[91] The closer an artificial sett is to the main sett being removed, the more likely it is to be used by the affected Badger group. Therefore, the artificial sett is proposed to be located approximately 60m to the north of S9. As the sett must be in place several months before works commence and the sett S9 is removed, the affected Badgers will have sufficient time to either adjust to the construction works in the vicinity of the artificial sett (which will involve blasting and rock breaking), relocate to another sett (e.g. S10), or construct a new sett elsewhere within their territory. Any disturbance from the construction works will be short-term and, even if the artificial sett is vacated during construction, its proximity to the operational road is not likely to deter badgers from occupying the sett at that time.

[92] Eldridge, B. & Wynn, J. (2011) Use of badger tunnels by mammals on Highways Agency schemes in England. *Conservation Evidence 8*. Pages 53-57

Where engineering constraints conflict with the recommended locations at construction, mammal underpasses may be moved to the nearest most suitable location, but not more than c.250 m away. The locations where Badger passage facilities will be provided are listed below in **Table 8.36** and are shown on **Figures 8.23.1** to **8.23.14**.

A number of the mammal passage structures lie within the modelled light spill zone and artificial lighting may affect their usage by Badger: structures C07/04, C07/01(b) and C12/01. Screening will be provided to ensure that the approaches and entrances to these structures are unaffected by light spill.

Table 8.36: Mammal passage facilities [93]

Ref. No.	Structure	Species and Description
C00/00	Pipe	Badger Dedicated 600mm concrete pipe will provide for mammal passage beneath the proposed road development
C00/01	Culvert	Bats A 2.5m wide by 1.35m high culvert will provide for bat passage beneath the proposed road development
C02/01b	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C03/01	Culvert	Bats A 2.5m wide by 1.2m high culvert will provide for bat passage beneath the proposed road development
C03/03	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C03/04	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C04/01	Culvert	Otter, Badger and Bats Raised mammal ledge, sited above flood water levels, incorporated into structure or a dedicated 600 mm concrete pipe on the east bank of the river/stream will provide for Otter and Badger passage A 5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C04/02	Culvert	Otter, Badger and Bats Raised mammal ledge, sited above flood water levels, incorporated into structure or a dedicated 600 mm concrete pipe on the east bank of the river/stream will provide for Otter and Badger passage

[93] Some of thes are also included in **Table 8.35** as part of the bat mitigation strategy but will also provide passage for many other mammal species

Ref. No.	Structure	Species and Description
		A 3.1m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C05/01	Pipe	Badger Dedicated 600mm concrete pipe will provide for mammal passage beneath the proposed road development
S06/01	Road Overbridge	Bats The unlit road overbridge will provide for bat passage across the proposed road development
C06/00	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C06/01	Culvert	Badger A 2.5m wide by 2.5m high culvert will provide for bat and badger passage beneath the proposed road development
C07/00	Culvert	Bats A 2.5m wide by 2m high culvert will provide for bat passage beneath the proposed road development
C07/02A	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C07/04	Pipe	Badger Dedicated 600mm concrete pipe will provide for mammal passage beneath the proposed road development
C07/01(b)	Pipe	Badger Dedicated 600mm concrete pipe will provide for mammal passage beneath the proposed road development
C08/01(a)	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C08/04	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C08/05	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C08/02	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development

Ref. No.	Structure	Species and Description
C09/01	Culvert	Bats and Badgers A 5m wide by 4m high culvert will provide for bat and badger passage beneath the proposed road development
C09/02	Culvert	Bats and Badgers A 5m wide by 4m high culvert will provide for bat and badger passage beneath the proposed road development
C09/03	Culvert	Bats and Badgers A 5m wide by 4m high culvert will provide for bat and badger passage beneath the proposed road development
C09/04	Culvert	Bats and Badgers A 5m wide by 4m high culvert will provide for bat and badger passage beneath the proposed road development
C09/05	Culvert	Bats and Badgers A 5m wide by 4m high culvert will provide for bat and badger passage beneath the proposed road development
S09/01	Road Overbridge	Bats and Badgers The road overbridge (9.6m wide by 5.3m high) will provide for bat and badger passage beneath the proposed road development
C09/06	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C09/07	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C10/01	Underpass	Bats and Badgers A 18m wide by 2.35m high underpass will provide for bat and badger passage beneath the proposed road development
S10/02	Road Overbridge	Bats The road overbridge (9.6m wide by 5.3m high) will provide for bat passage beneath the proposed road development
C10/02	Pipe	Bats and Badger Dedicated 1200mm concrete pipe will provide for mammal passage beneath the proposed road development
C12/01	Pipe	Badger Dedicated 600mm concrete pipe will provide for mammal passage beneath the proposed road development
C12/02	Culvert	Bats

Ref. No.	Structure	Species and Description
		A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C12/03	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
C12/04	Culvert	Bats A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development
S12/02	Green bridge	Bats and Badgers The Green Bridge (30m in width) will provide for bat and mammal passage over the proposed road development
C13/01	Culvert	Bats and Badger A 2.5m wide by 1.5m high culvert will provide for bat and badger passage beneath the proposed road development

Mammal-resistant fencing will be required to guide badgers to the underpasses and will be installed in accordance with the specification outlined in *Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes*, and TIIs mammal resistant fencing specification (currently CC-SCD-00320/00319), and will include badger proofing of emergency access roads and other similar access points, where located in areas where mammal-resistant fencing is to be installed. The locations where mammal-resistant fencing is to be installed are shown on **Figures 8.23.1** to **8.23.14**.

In accordance with the recommendations described in the *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes* (National Roads Authority, 2006), quarterly monitoring of the effectiveness of the mitigation measures will be undertaken in the first year after the completion of construction works (for example, fencing inspections to check for gaps and underpass inspection to check for blockages).

8.6.7.4 Other Mammal Species

8.6.7.4.1 Measures to Protect Other Mammal Species during Construction

Habitat degradation - water quality

The mitigation measures relating to the protection of water quality in receiving watercourses during construction are outlined in **Section 8.6.4** and detailed in **Section 11.6.2** of **Chapter 11, Hydrology**.

8.6.7.4.2 Measures to Protect Other Mammal Species during Operation

Habitat Severance/Barrier Effect

The combination of the network of dedicated mammal passage facilities, along with the bridge and viaduct structures (the proposed River Corrib Bridge and the Menlough Viaduct), and the retained lands above the proposed Lackagh Tunnel and the Galway Racecourse Tunnel provide a high degree of landscape permeability along the route of the proposed road development for all of the other mammal species recorded, or likely to be present, within the study area. The locations are described above in **Table 8.36** and are shown on **Figures 8.23.1** to **8.23.14**.

Wildlife passage facilities have been shown to be used by small mammal species such as Hedgehog, Pygmy shrew and Wood mouse (Dolan 2006; Eldridge & Wynn 2011); although their effectiveness has not been tested. However, it is likely that the high permeability of the proposed road development will reduce the effects of any severance or barrier effect that may be associated with the proposed road development (Haigh, 2012) such that the species' conservation status would not be affected. Therefore, habitat severance and barrier effect are not likely to result in a significant negative residual effect, at any geographic scale.

Collision Risk

There are no practical or effective means of preventing small mammals or arboreal mammal species (such as the Pine marten and Red squirrel, which are highly skilled climbers) from accessing the proposed road development. As discussed above in relation to severance and barrier effect, the design of the proposed road development provides for a high degree of permeability across the proposed road development and this offers the most practical solution to minimise the potential interaction of small mammals with the proposed road development. Collision risk is therefore, not likely to affect the species' conservation status and not likely to result in a significant negative residual effect, at any geographic scale.

8.6.8 Invertebrates

8.6.8.1 Marsh whorl snail

8.6.8.1.1 Measures to Protect the Marsh whorl snail during Construction

Habitat Degradation – Surface Water Quality

The mitigation measures relating to the protection of water quality in receiving watercourses during construction are outlined in **Section 8.6.4** and detailed in **Section 11.6.2** of **Chapter 11**, **Hydrology**.

Habitat Degradation – Groundwater

The mitigation measures relating to the protection of the groundwater regime during construction are described in **Section 10.6.2** of **Chapter 10, Hydrogeology**.

8.6.8.1.2 Measures to Protect the Marsh whorl snail during Operation

Habitat Degradation – Groundwater

The mitigation measures relating to the protection of the groundwater regime during operation are described in **Section 10.6.3** of **Chapter 10, Hydrogeology**.

8.6.8.2 Marsh fritillary butterfly

8.6.8.2.1 Measures to Protect the Marsh fritillary butterfly during Construction

Mortality Risk

To avoid the destruction of Marsh fritillary eggs or the mortality of Marsh fritillary caterpillars, the following mitigation strategy will be implemented in relation to the site clearance works:

- All areas within the proposed development boundary, which have been identified as suitable habitat to support the Marsh fritillary butterfly, will be subject to a pre-construction larval web survey. This will be undertaken during the mid-August to the end of September window immediately preceding site clearance works
- If larval webs are present, they will be translocated to another area of suitable habitat; either outside of the proposed development boundary or, if within, to an area of suitable habitat that will remain unaffected by construction works for the duration
- Once all larval webs have been removed from the affected areas, or if no larval webs were recorded, the vegetation will be immediately cleared or cut to ground level to render the area unsuitable for the species to recolonise. The vegetation shall be maintained in this state until such time as the topsoil is removed.

8.6.9 Birds

8.6.9.1 Breeding Birds

8.6.9.1.1 Measures to Protect Breeding Birds during Construction

Habitat Loss, Disturbance and Destruction of Breeding Habitat

General

Where feasible, vegetation (*e.g.* hedgerows, trees, scrub and grassland) will not be removed, between the 1 March and the 31 August, to avoid direct impacts on nesting birds. Where the construction programme does not allow this seasonal restriction to be observed, then these areas will be inspected by a suitably qualified ecologist for the presence of breeding birds prior to clearance. Areas found not to contain nests will be cleared within 3 days of the nest survey, otherwise repeat surveys will be required.

Barn owl

To minimise the effects of current levels of disturbance to the Barn owl nest site at Menlo Castle, and thereby reduce any cumulative effect that construction activities nearby may have, alternative nesting sites will be provided in the vicinity. Three Barn owl nest boxes will be erected across the area shown on **Figures 8.23.1** to **8.23.14** and will consist of either nest boxes erected on suitable trees or pole-mounted nest boxes. Preference will be given to erecting nest boxes on suitable trees, where possible.

Tree mounted boxes will be erected at least 3m above ground level on a mature tree with few or no low branches to obscure the nest box. The selected tree shall be either isolated in a hedgerow or situated on a woodland edge with the access hole facing open ground.

Pole-mounted nest boxes will be erected at a minimum height of 4.5m above ground.

The nest box design (e.g. entrance hole size, floor area and depth from the bottom of the entrance hole to the nest) shall be in accordance with the design requirements published by The Barn Owl Trust (http://www.barnowltrust.org.uk/). Nest boxes will be inspected annually for defects/damage and cleaned out/repaired as required to ensure waterproofness and the internal box depth.

Peregrine falcon

To minimise the potential for construction works near Lackagh Quarry to disturb the Peregrine falcon nest site, works from the Lackagh Tunnel to the N84 Headford Road Junction will commence prior to mid-February. This will ensure that any construction related disturbance, if its magnitude displaces Peregrine from the quarry for the duration of construction works, can influence the selection of the nest site and will not impact upon an incubating female on the nest. The installation of rock bolts on the cliff faces in the vicinity of the nest site will be undertaken in a sensitive manner (as advised by a suitably experienced ecologist) so as to minimise any potential disturbance to the nest site during the breeding season, particularly if the nest site is occupied.

8.6.9.1.2 Measures to Protect Breeding Birds during Operation

Habitat loss, Habitat Severance/Barrier Effect and Mortality Risk

General

Planting of woodland, hedgerow and grassland habitats along the proposed road development as detailed in the landscape drawings (**Figures 12.2.01** to **12.2.15**) will provide compensatory habitat for some bird species. In some instances, such as in large areas of improved agricultural grassland with no vegetated field boundaries, this will improve the diversity of bird habitat.

Many species may not nest near a road development due to disturbance (e.g. drowning out of bird song by traffic noise). Whilst the planting is not likely to fully offset the loss of breeding habitat (due to the proximity of road traffic disturbance on the operational road) it is likely to provide additional foraging habitat for some species.

To further minimise the effects of breeding habitat loss, a total of 20 nest boxes will be erected by a qualified ecologist in suitable locations away from the busy junctions/roadways. The siting and type of nest boxes will be decided on by an ecologist at locations where trees will be planted or retained along the proposed road development; as shown on **Figures 12.2.01** to **12.2.15**.

Barn owl

Sections along the proposed road development will be planted with dense low growing scrub cover (e.g. blackthorn) to discourage Barn owls from foraging near the proposed road development. The planting will be of a density to minimise the lag time between planting and obtaining sufficient ground cover to deter foraging Barn owl.

In areas where there is a high probability that Barn owls may regularly attempt to cross the proposed road development (the section of embankment between Ch. 9+600 and Ch. 10+100), lines of closely spaced (approximately 2m centres) trees, greater than 3m in height, will be planted along the top of the embankments of the proposed road development; outside of the safety barrier and clear zone. The understorey will also be densely planted. This is to present a solid vegetated barrier to deflect Barn owl from these high-risk areas and/or force birds to fly over the proposed road development above the road traffic.

All mitigatory planting will be in place at the earliest feasible stage during construction to ensure that the mitigation is functioning as soon as possible, following the opening of the proposed road development.

The locations where planting will be used to reduce the risk of Barn owl mortality from road traffic are shown on **Figures 8.23.1** to **8.23.14** and on the landscape drawings (**Figures 12.2.01** to **12.2.14**).

Following implementation of all mitigation measures and completion of construction of the proposed road development, the following monitoring measures are proposed:

- Surveys will be undertaken of roadside planting schemes at the end of years one and two with the objective of identifying and replacing failed plantings
- A road casualty survey to record barn owl mortalities along the route of the proposed road development will be conducted once per week for a period of two years by a suitably qualified and experienced ornithologist. The proposed road development will be driven at a steady pace in both directions so that all sections and both sides of the route will be surveyed correctly. Where noted, all barn owl mortalities will be assigned to either the “breeding” season (March to July) or “non-breeding” season (August to January). Location details of the casualty will be recorded, including a 10-digit GPS co-ordinate, position on the route (central median, hard shoulder, or verge) and orientation (southbound,

northbound, eastbound, and westbound). The age class of the bird will be determined and classed as either "pre-breeding" if first or second calendar year recovered before March, or "adult" if the bird is second calendar year recovered later than March or older. The adjacent habitat feature will be noted. This methodology is in line with that utilised for *Barn Owl population status and the extent of road mortalities in relation to the Tralee Bypass* (O'Clery et al., 2016)

- Monitoring to determine activity and breeding status of all active sites within 5km of the proposed road development over two breeding seasons (March to July). This will be carried out concurrently with the road casualty survey, and will involve visits to known and potential nesting sites to determine brood size and breeding success. Where accessible, nests will be visited in order to ring owlets (subject to an appropriate licence from the NPWS)

A report summarising the findings of the above monitoring will be submitted at the end of year two to the NPWS. The report may include further recommendations pending survey outcomes.

8.6.9.2 Wintering Birds

8.6.9.2.1 Measures to Protect Wintering Birds during Construction

Construction noise will be kept to a minimum in accordance with BS 5228 (2009).

The contract documents will specify that the Contractor, undertaking the construction of the works, will be obliged to take specific noise abatement measures and will comply with the best practice outlined in British Standard BS 5228 – 1: 2009 +A1 2014: *Code of practice for noise and vibration control on construction and open sites – Noise* and the NRA (now TII) guidelines *Good Practice Guideline for the Treatment of Noise during the planning of National Road Schemes* (National Roads Authority, 2014).

Blasting associated with the eastern approach to Lackagh Quarry (Ch. 11+800 to Ch. 12+100) will be carried out between the months of April to September (inclusive) to minimise the exposure of wintering birds at Ballindooley Lough to blasting-related disturbance.

Blasting associated with the cutting at Castlegar (Ch. 12+550 to Ch. 13+650) will take approximately nine months to complete, with an estimated five blast events per week. To minimise the exposure of wintering birds at Ballindooley Lough to blasting-related disturbance, all of those nine months must be in the April to September period (inclusive) within consecutive years.

8.6.9.2.2 Measures to Protect Wintering Birds during Operation

Disturbance/Displacement

Despite the assessment conclusion that disturbance during operation of the proposed road development is not likely to result in any population level effects on wintering birds, hedgerow planting along the proposed development boundary (at the locations shown on the landscape drawings (**Figures 12.2.01** to **12.2.14**) will further minimise the potential disturbance to wintering birds from road traffic.

8.6.10 Amphibians

8.6.10.1 Measures to Protect Amphibians during Construction

Habitat Loss, Disturbance & Mortality Risk

If works to clear any of the habitat features suitable to support amphibian species are to begin during the season where frogspawn or tadpoles may be present (February – mid-summer), or where breeding adult newts, their eggs or larvae may be present (mid-March – September), a pre-construction survey will be undertaken to determine whether breeding amphibians are present.

In the case of Common frog, any frog spawn, tadpoles, juvenile or adult frogs present will be captured and removed from affected habitat by hand net and translocated to the nearest area of available suitable habitat, beyond the ZoI of the proposed road development.

In the case of Smooth newt, individuals will be captured and removed from affected habitat either by hand net or by trapping and translocated to the nearest area of available suitable habitat, beyond the ZoI of the proposed road development. If used, the type and design of traps shall be approved by the NPWS. This is a standard and proven method of catching and translocating Smooth nest.

If the size or depth of the habitat feature is such that it cannot be determined whether all amphibians have been captured, it will be drained under the supervision of a suitably experienced ecologist to confirm that no amphibian species remain before it is destroyed or infilled. Any mechanical pumps used to drain the habitat feature will have a screen fitted, and be sited, such that no amphibian species can be sucked into the pump mechanism.

Any capture and translocation works shall be undertaken immediately in advance of site clearance/construction works commencing.

Habitat Degradation – Surface Water Quality

The mitigation measures relating to the protection of water quality in receiving watercourses during construction are outlined in **Section 8.6.4** and detailed in **Section 11.6.2** of **Chapter 11, Hydrology**.

8.6.10.2 Measures to Protect Amphibians during Operation

Habitat Severance & Barrier Effect

The combination of the network of wildlife passage facilities, culverts, bridges and viaduct structures (e.g. the proposed River Corrib Bridge and the Menlough Viaduct) provide a high degree of landscape scale permeability along the proposed road development. This will serve to maintain connectivity at a local scale between sites used by amphibian species and is predicted to reduce any long-term severance or barrier effects associated with the proposed road development such that the conservation status of amphibian species is not likely to be negatively affected.

The locations of the wildlife passage facilities are described above in **Table 8.36** and are shown on **Figures 8.23.1** to **8.23.14**.

8.6.11 Reptiles

8.6.11.1 Measures to Protect Reptiles during Construction

Habitat Loss, Disturbance & Mortality Risk

Given the broad range of habitat types favoured by the Common lizard, and that the majority of the proposed road development passes through mosaics of such habitats, site clearance works at any time of year in suitable habitat are highly likely to encounter the species, cause disturbance and have the potential to kill or injure individuals.

In order to minimise the risk of site clearance and construction works disturbing, or causing the mortality of, Common lizard the following schedule of site clearance works will be followed in the areas highlighted on **Figures 8.10.1** to **8.10.8**, where the presence of Common lizard has been confirmed:

- grass, scrub or heath vegetation will be removed during the winter period, where possible, avoiding potential Common lizard hibernacula sites (dry sites which provide frost-free conditions e.g. stone walls, underground small mammal burrows, piles of dead wood or rubble)
- where this is not possible and clearance will be undertaken during the active season (March through to September, inclusive), vegetation will be cut first to approximately 15cm, and then to the ground, under supervision of an ecologist. This will allow the opportunity for lizards to be displaced by the disturbance and leave the affected area
- stone walls (or other potential hibernacula sites) will be removed during the active season (March through to September, inclusive) under the supervision of an ecologist, when they are less likely to be in use by torpid lizards

8.6.11.2 Measures to Protect Reptiles during Operation

Habitat Severance & Barrier Effect

The combination of the network of wildlife passage facilities, culverts, bridges and viaduct structures (e.g. the proposed River Corrib Bridge and the Menlough Viaduct) provide a high degree of landscape scale permeability along the proposed road development. This will serve to maintain connectivity at a local scale between sites used by reptile species and is predicted to reduce any long-term severance or barrier effects associated with the proposed road development such that the conservation status of reptile species is not likely to be negatively affected.

The locations of the wildlife passage facilities are described above in **Table 8.36** and are shown on **Figures 8.23.1** to **8.23.14**.

8.6.12 Fish

8.6.12.1 Measures to Protect Fish Species during Construction

Habitat Loss

The structures have been designed in consultation with IFI and in accordance with the design criteria set out in *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes* (National Roads Authority**,** 2005) and the *Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters* (IFI, 2016). These measures, which include, in broad terms replicating the existing channel profile and substrate, will likely minimise the effects of habitat loss to a degree but it is acknowledged that this will be limited by the fact that they are artificial channels within a light limiting box structure.

To minimise the effects of habitat loss on fish species, all sections of river/stream channel within the proposed development boundary, but not within the footprint of the proposed road development and associated infrastructure, will be protected from site clearance and construction works. Rivers/streams will be fenced off at a minimum distance of 5m from the river bank and within this zone the natural riparian vegetation will be retained.

Habitat Degradation – Surface Water Quality

The mitigation measures relating to the protection of water quality in receiving watercourses during construction are outlined in **Section 8.6.4** and detailed in **Section 11.6.2** of **Chapter 11, Hydrology**.

Habitat Degradation – Groundwater

The mitigation measures relating to the protection of the groundwater regime during construction are described in **Section 10.6.2** of **Chapter 10, Hydrogeology**.

Mortality Risk & Disturbance/Displacement

To minimise the potential effects of construction works on fish species the following mitigation measures will be implemented:

- No instream works will be carried out between the months of October and June (inclusive) to avoid the most sensitive time for fish species and fish species movements
- Design of new sections of river channel shall be in accordance with the principles outlined in *Channels & Challenges. Enhancing Salmonid Rivers*. (O'Grady, 2006)
- Immediately prior to rivers/streams being diverted into a newly constructed river channel or culvert, they will be electrofished (if required) to capture and transfer fish from the original channel to the new one. Once the watercourse has been diverted this will be followed by a manual search of the original watercourse to transfer any remaining fish to the new river/stream channel

- Any water abstraction points required for dust suppression will be agreed with IFI and the suction head shall be screened to ensure that fish are not removed during the abstraction process

Habitat Severance/Barrier Effect

All temporary crossing structures used to cross watercourses during construction will be designed in accordance with the *Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters* (IFI, 2016) and *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes* (National Roads Authority**,** 2005) to maintain fish and macroinvertebrate passage, and to prevent sedimentation and erosion.

8.6.13 Summary of Mitigation Measures

Table 8.37 below presents an overall summary of the mitigation measures and how these relate to the likely significant effects of the proposed road development on biodiversity.

Table 8.37: Summary of the Mitigation Measures Required to Address the Likely Significant Effects of the Proposed Road Development on Biodiversity

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
Designated Areas for Nature Conservation				
Lough Corrib cSAC (including Lough Corrib pNHA)	International (National)	**Construction** Habitat loss Habitat degradation – tunnelling/excavation Habitat degradation – hydrogeology Habitat degradation – hydrology Habitat degradation – air quality Habitat degradation – non-native invasive plant species Mortality risk **Operation** Habitat degradation – hydrogeology Habitat degradation – non-native invasive plant species Mortality risk	Likely significant effect at the international geographic scale	see Section 10 of the NIS
Galway Bay Complex cSAC (including Galway bay Complex pNHA)	International (National)	**Construction** Habitat degradation – hydrology Habitat degradation – non-native invasive plant species Barrier effect Mortality risk	Likely significant effect at the international geographic scale	see Section 10 of the NIS

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
Lough Corrib SPA (including Lough Corrib pNHA)	International (National)	**Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology Disturbance/displacement **Operation** Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale	see Section 10 of the NIS
Inner Galway Bay SPA including Galway bay Complex pNHA)	International (National)	**Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology Disturbance/displacement **Operation** Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale	see Section 10 of the NIS
Moycullen Bogs NHA	National	**Construction** Habitat degradation – air quality Habitat degradation – non-native invasive plant species Habitat degradation – hydrology **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale	Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5** Water quality during construction – **Section 8.6.4**

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
Habitats (outside of designated areas for nature conservation)				
Limestone pavement [*8240]	International Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the international geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**
Petrifying springs [*7220]	International Importance	**Construction** Habitat loss	Likely significant effect at the county geographic scale (see **Section 8.5.4.3** under petrifying springs)	To reduce the scale of habitat loss – see **Section 8.6.2.1**
Calcareous grassland [*6210/6210]	International/National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale (No *6210 affected – see **Section 8.5.4.3** under Calcareous grassland))	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
				– **Section 8.6.6** and **Appendix A.7.5**
Dry heath [4030]	National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**
Wet heath [4010][94]	National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – groundwater **Operation** Habitat degradation – groundwater	Likely significant effect at the national geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Groundwater during construction and operation – **Section 8.6.5**
Molinia meadow [6410]	National Importance	**Construction** Habitat loss Habitat degradation – air quality	Likely significant effect at the national geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1**

[94] Including areas of Wet heath/Dry heath/*Molinia* meadow [4010/4030/6410] mosaic

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
		Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species		Air quality during construction - **Section 8.6.3** Groundwater during construction and operation – **Section 8.6.5**
Residual alluvial forest [*91E0]	International Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the international geographic scale	Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**
Turloughs [*3180]	International Importance	**Construction** Habitat loss Habitat degradation – surface water quality Habitat degradation – groundwater Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – groundwater Habitat degradation – non-native invasive plant species	Likely significant effect at the international geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction – **Section 8.6.3** Water quality during construction – **Section 8.6.4** Groundwater during construction and operation – **Section 8.6.5**

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
				Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**
Hard water lakes [3140]	National Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the national geographic scale	Water quality during construction – **Section 8.6.4**
Mesotrophic lakes (FL4) *Part of Ballindooley complex*	County Importance[95]	**Construction** Habitat degradation – surface water quality	Likely significant effect at the county geographic scale	Water quality during construction – **Section 8.6.4**
Eutrophic lakes (FL5) *Part of Ballindooley complex*	County Importance[96]	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the county geographic scale	Water quality during construction – **Section 8.6.4** Groundwater during construction – **Section 8.6.5**
Calcareous springs (FP1) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1**
Cladium fen [*7210]	International Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the international geographic scale	Water quality during construction – **Section 8.6.4**

[95] On the basis that it forms part of the wetland complex at Ballindooley Lough
[96] On the basis that it forms part of the wetland complex at Ballindooley Lough

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
Hydrophilous tall herb [6430]	International Importance	(see Lough Corrib cSAC above) **Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology **Operation** Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale	see Section 10 of the NIS
Alkaline fens [7230]	National Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the national geographic scale	Water quality during construction – **Section 8.6.4**
Reed and large sedge swamps (FS1) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality	Likely significant effect at the local geographic scale	Water quality during construction – **Section 8.6.4**
Tall-herb swamps (FS2) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None
Eroding/upland rivers (FW1)	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality	Likely significant effect at the local geographic scale	Water quality during construction – **Section 8.6.4**
Depositing/lowland rivers (FW2) River Corrib	International Importance	The River Corrib forms part of see Lough Corrib cSAC (see above and NIS)	Likely significant effect at the international geographic scale	see Section 10 of the NIS
Terryland River	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
Drainage ditches (FW4)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None
Marsh (GM1)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None
Dry calcareous and neutral grassland (GS1) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None
Dry meadows and grassy verges (GS2) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None
Dry-humid acid grassland (GS3) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**
Wet grassland (GS4) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None

Ecological Receptor	**Ecological Valuation (after National Roads Authority, 2009)**	**Impacts with the Potential to result in Likely Significant Effects**	**Potential Impact Significance**	**Mitigation Measures**
Rich fen and flush (PF1) Non-Annex I habitat type	County Importance	**Construction** Habitat degradation – surface water quality Habitat degradation – air quality	Likely significant effect at the county geographic scale	Water quality during construction – **Section 8.6.4** Air quality during construction – **Section 8.6.3**
Poor fen and flush (PF2) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality **Operation** Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Air quality during construction – **Section 8.6.3**
(Mixed) broadleaved woodland (WD1)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**
Mixed broadleaved/conifer woodland (WD2)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
(Mixed) conifer woodland (WD3)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None
Hedgerows (WL1)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**
Treelines (WL2)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
Oak-ash-hazel woodland (WN2) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat degradation – air quality Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**
Scrub (WS1) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None
Fauna Species				
Badger	Local Importance (Higher Value)	**Construction** Loss of breeding/resting sites Disturbance/displacement **Operation** Habitat severance/barrier effect Mortality risk	Likely significant effect at the local geographic scale	Measures to protect Badger during construction – **Section 8.6.7.3.1** Measures to protect Badger during operation – **Section 8.6.7.3.2**
Otter	International Importance	**Construction** Habitat degradation - water quality **Operation** Habitat severance/barrier effect Mortality risk	Likely significant effect at the local geographic scale	Measures to protect Otter during construction – **Section 8.6.7.1.1** Measures to protect Otter during operation – **Section 8.6.7.1.2**

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
Other mammal species protected under the Wildlife Acts	Local Importance (Higher Value)	**Construction** Habitat degradation - water quality **Operation** Habitat severance/barrier effect Mortality risk	Likely significant effect at the local geographic scale	Measures to protect other mammal species (excl. bats) during construction – **Section 8.6.7.4.1** Measures to protect other mammal species (excl. bats) during operation – **Section 8.6.7.4.2**
Lesser horseshoe bat	National Importance	**Construction** Roost loss Habitat loss Habitat fragmentation Disturbance/displacement **Operation** Mortality Barrier/severance effects Disturbance/displacement	Likely significant effect at the national geographic scale	Measures to protect bats during construction – **Section 8.6.7.2.1** Measures to protect bats during operation – **Section 8.6.7.2.2**
All other bat species	Local Importance (Higher Value)		Likely significant effect at the local geographic scale	Measures to protect bats during construction – **Section 8.6.7.2.1** Measures to protect bats during operation – **Section 8.6.7.2.2**
Marsh whorl snail	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater **Operation** Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Measures to protect the Marsh whorl snail during construction – **Section 8.6.8.1.1** Measures to protect the Marsh whorl snail during

Ecological Receptor	**Ecological Valuation (after National Roads Authority, 2009)**	**Impacts with the Potential to result in Likely Significant Effects**	**Potential Impact Significance**	**Mitigation Measures**
				operation – **Section 8.6.8.1.2**
Marsh fritillary butterfly	County Importance	**Construction** Mortality risk	Likely significant effect at the local geographic scale	Measures to protect the Marsh fritillary butterfly during construction – **Section 8.6.8.2.1**
SCI bird species	International	*see Lough Corrib SPA and Inner Galway Bay SPA above*	Likely significant effect at the international geographic scale	see Section 10 of the NIS
Barn owl	County Importance	**Operation** Mortality risk	Likely significant effect at the county geographic scale	Measures to protect breeding birds during operation – **Section 8.6.9.1.2**
Peregrine falcon	County Importance	**Construction** Disturbance/displacement **Operation** Disturbance/displacement	Likely significant effect at the county geographic scale	Measures to protect breeding birds during construction – **Section 8.6.9.1.1** Measures to protect breeding birds during operation – **Section 8.6.9.1.2**
All other breeding bird species (non SCI)	Local Importance (Higher Value)	**Construction** Mortality risk Disturbance/displacement **Operation** Mortality risk	Likely significant effect at the local geographic scale	Measures to protect breeding birds during construction – **Section 8.6.9.1.1** Measures to protect breeding birds during

Ecological Receptor	**Ecological Valuation (after National Roads Authority, 2009)**	**Impacts with the Potential to result in Likely Significant Effects**	**Potential Impact Significance**	**Mitigation Measures**
		Disturbance/displacement		operation – **Section 8.6.9.1.2**
All other wintering bird species (non-SCI)	Local Importance (Higher Value)	**Construction** Disturbance/displacement (Ballindooley Lough) Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Measures to protect wintering birds during construction – **Section 8.6.9.2.1** Measures to protect wintering birds during operation – **Section 8.6.9.2.2**
Smooth newt Common frog	Local Importance (Higher Value)	**Construction** Habitat loss Disturbance & mortality risk Habitat degradation – surface water quality **Operation** Habitat severance/barrier effect	Likely significant effect at the local geographic scale	Measures to protect amphibians during construction – **Section 8.6.10.1** Measures to protect amphibians during operation – **Section 8.6.10.2**
Common lizard	Local Importance (Higher Value)	**Construction** Habitat loss Disturbance & mortality risk **Operation** Habitat severance/barrier effect	Likely significant effect at the local geographic scale	Measures to protect reptiles during construction – **Section 8.6.11.1** Measures to protect reptiles during operation – **Section 8.6.11.2**
Atlantic salmon		**Construction**		

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures
European eel	International Importance	Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Measures to protect fish species during construction – **Section 8.6.12.1**
All other fish species recorded	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Measures to protect fish species during construction – **Section 8.6.12.1**
Local Biodiversity Areas				
Local biodiversity areas	The value of the biodiversity receptors recorded in the vicinity of the proposed road development, across the local biodiversity areas, range from Local Importance (Lower Value) to Internationally Important	Combinations of all of the potential impacts noted above The specific impacts are related to and dependent upon the potential impacts of the proposed road development on each of the individual ecological receptors that make up the biodiversity resource within a given local biodiversity area	Likely significant effects from local up to the international geographic scale	All of the mitigation measures included within **Section 8.6** The specific mitigation measures are related to and dependent upon the potential impacts of the proposed road development on each of the individual ecological receptors that make up the biodiversity resource within a given local biodiversity area

8.7 Residual Impacts

8.7.1 Designated Areas for Nature Conservation

8.7.1.1 European Sites

The assessment, presented in the NIS, of the potential for the proposed road development to impact upon Lough Corrib cSAC, Lough Corrib SPA, Galway Bay Complex cSAC or Inner Galway Bay SPA concluded that, with the implementation of the mitigation measures proposed, the proposed road development does not pose a risk of adversely affecting (either directly or indirectly) the integrity any European site, either alone or in combination with other plans or projects.

Although the proposed road development will not adversely affect the integrity of any of these European sites, the proposed road development will have some level of residual impact on biodiversity within the boundary of Lough Corrib cSAC. This is not the case of Galway Bay Complex cSAC, Inner Galway Bay SPA and Lough Corrib SPA, which are remote from the proposed development boundary, as the potential impact pathways connecting the proposed road development to these European sites are fully mitigated, as assessed in the NIS (and throughout this chapter).

The residual impacts on non QI habitats and species within Lough Corrib cSAC are as follows:

- At the proposed River Corrib crossing the loss of c.0.15ha of a Dry meadows and grassy verges (GS2), Scrub (WS1), Buildings and artificial surfaces (BL3) and Wet grassland (GS4) mosaic on the west bank and, on the east bank, c.1.25ha of Dry calcareous and neutral grassland (GS1), c.1.45ha of Mixed broadleaved woodland (WD1) and loss of a small area of gravel track
- At the proposed drainage outfall for the N59 Link Road North c.0.03ha of a Treeline (WL2), Scrub (WS1) and Dry meadows and grassy verges (GS2) mosaic
- In the Menlough/Coolagh Lakes area c.0.08ha of Oak-Ash-Hazel Woodland (WN2), c.0.01ha of Wet grassland (GS4), c.0.01ha of Dry calcareous and neutral grassland (GS1), c.0.02ha of Scrub (WS1) along with some local road and gravelled access track
- In the vicinity of the proposed Lackagh Tunnel c.0.21ha of Oak-Ash-Hazel Woodland (WN2) and Scrub (WS1), c.0.09ha of Scrub (WS1), c.0.1ha of Dry calcareous and neutral grassland (GS1), a short section (c.20m) of Treeline (WL2), and c.0.08ha of a mosaic of Treelines (WL2), Scrub (WS1), Dry meadows and grassy verges (GS2) and Spoil and Bare Ground (ED2) habitat
- Impacts of the proposed road development on the local bat populations

None of these residual biodiversity effects compromise the overall biodiversity resource of Lough Corrib cSAC in any way that relates to the integrity of that site and therefore, no likely significant effects are predicted at any geographic scale

Therefore, the proposed road development will not result in a likely significant residual effect on any European site(s).

8.7.1.2 Natural Heritage Areas & proposed Natural Heritage Areas

The residual impacts of the proposed road development on Lough Corrib pNHA and Galway Bay Complex pNHA are as per Lough Corrib cSAC/SPA and Galway Bay Complex cSAC/Inner Galway Bay SPA in **Section 8.7.1.1**. As per the conclusions of that assessment the proposed road development is not likely to have a significant residual effect on either Lough Corrib pNHA or Galway bay Complex pNHA.

Mititgation measures will be implemented to ensure that the peatland habitats for which Moycullen Bogs NHA is designated, and the species they support, will not be affected by the proposed road development during construction or operation.

Therefore, the proposed road development will not affect the integrity of, or result in a likely significant negative residual effect on, any Natural Heritage Areas or proposed Natural Heritage Areas.

8.7.2 Habitats

A mitigation strategy will be implemented during construction and operation to minimise the effects of habitat loss and habitat degradation on biodiversity (**Section 8.6.2**).

Despite these mitigation measures, the proposed road development will result in permanent area loss of a number of Annex I habitat types. None of the areas of Annex I habitat that will be permanently lost are located with any European sites. In the case of the priority Annex I habitats affected, this results in a likely significant negative residual effect at the international geographic scale, as it is adding to an ongoing trend of habitat loss for these habitats of highest conservation concern that are in danger of disappearance at a European level. For non-priority Annex I habitat types, the habitat loss is considered to constitute a likely significant negative residual effect at the national geographic scale, as loss of habitat area affects the conservation status of each of these habitats nationally. The habitat types, and areas affected, are summarised in **Table 8.38** below.

Table 8.38: Summary of *Annex I/Annex I habitat loss

Annex I habitat type	Total Area within the proposed development boundary Potentially Impacted	Area to be Retained	Actual Permanent area of habitat loss	Residual Impact Significance
Turlough [*3180]	c.0.04ha within proposed development boundary (total	All (c.0.04ha)	None	No likely significant residual effect

Annex I habitat type	Total Area within the proposed development boundary Potentially Impacted	Area to be Retained	Actual Permanent area of habitat loss	Residual Impact Significance
	area of Turlough is c.0.1ha)			
Petrifying springs [*7220]	Two Petrifying spring feature at Lackagh Quarry	One feature to be retained	One Petrifying spring feature	Likely significant residual effect at the county geographic scale
Residual alluvial forest [*91E0]	c.0.1ha	None	c.0.1ha	Likely significant residual effect at the international geographic scale
Limestone pavement [*8240]	c.2.18ha	c.1.64ha	c.0.54ha	Likely significant residual effect at the international geographic scale
Limestone pavement/Calcareous grassland [*8240/6210]	c.0.12ha	All (Above Lackagh Tunnel – c.0.12ha)	None	No likely significant residual effect
Wet heath [4010]	c.2.06ha	None	c.2.06ha	Likely significant residual effect at the national geographic scale
Dry heath [4030]	c.1.96ha	c.0.11ha	c.1.85ha	Likely significant residual effect at the national geographic scale
Wet heath/Dry heath/*Molinia* mosaic [4010/4030/6410]	c.1.13ha	c.0.26ha	c.0.87ha	Likely significant residual effect at the national geographic scale

Annex I habitat type	Total Area within the proposed development boundary Potentially Impacted	Area to be Retained	Actual Permanent area of habitat loss	Residual Impact Significance
Calcareous grassland [6210]	c.1.14ha	c.0.44ha	c.0.7ha	Likely significant residual effect at the national geographic scale
Molinia meadow [6410]	c.1.02ha	c.0.74ha	c.0.28ha	Likely significant residual effect at the national geographic scale
Total area	c.9.75ha of Annex I habitats and 2 Petrifying spring features	c.3.35ha of Annex I habitats and 1 Petrifying spring feature	c.6.4ha of Annex I habitats and 1 Petrifying spring feature	

Similarly, despite the mitigation measures the proposed road development will result in likely significant negative residual effects, at the local geographic scale, on the following habitat of a local biodiversity value:

- Calcareous springs (FP1) - fifteen features
- Dry-humid acid grassland (GS3) - c.7.81ha
- Poor fen and flush (PF2) - c.0.13ha
- (Mixed) broadleaved woodland (WD1) - c.2.62ha
- Hedgerows (WL1) - c.7.8km
- Treelines (WL2) - c.4km

8.7.3 Rare and protected plant species

As there are no rare or legally protected plant species present within the ZoI of the proposed road development they will not be affected. Therefore, no mitigation measures are required and no residual impacts are predicted.

8.7.4 Mammals

8.7.4.1 Otter

A mitigation strategy will be implemented (and monitored) to minimise the risk of the proposed road development affecting water quality in receiving watercourses/waterbodies during construction which will ensure that there is not a likely significant negative residual effect on the local Otter population (**Section 8.6.7.1**).

Mitigation measures will be implemented (and monitored) to ensure that, during operation, the proposed road development does not result in a significant negative effect on the local Otter population as a result of severance/barrier effects or mortality risk: the provision of mammal passage facilities in conjunction with mammal resistant fencing (**Section 8.6.7.1.2**).

Therefore the proposed road development will not result in a likely significant negative residual effect on Otter, at any geographic scale.

8.7.4.2 Bats

A mitigation strategy will be implemented (and monitored) prior to and during construction to minimise the risk of direct harm to bats during demolition and tree felling, to provide temporary linear features to reduce the effects of severance of flight paths during construction. Significant residual impacts will still remain as some of the activities are unavoidable and can only be mitigated to a certain level of certainty:

- Demolition of 14 buildings within the proposed development boundary which will affect local populations of Soprano pipistrelle bats, Common pipistrelle bats, Brown long-eared bats and Lesser horseshoe bats
    - One maternity roost is being demolished, a Brown long-eared roost at Aughnacurra (PBR256)
    - One satellite roost for Lesser horseshoe bats will be demolished at Aughnacurra (PBR178) (a satellite roost for the Menlo Castle (PBR06) Lesser horseshoe maternity roost)
- Loss of foraging habitat is regarded to be most significant in the Menlough area where woodland-pasture-hedgerow habitat is being lost and is within the CSZ for the nationally-important population of Lesser horseshoe bats
- Inevitable elevated mortality rates due to vehicle collisions
- Mortality and severance/barrier effects caused by the proposed road development on individual bats. Whilst best practice has been followed in the design of the proposed road development and the inclusion of underpasses/culverts and a wildlife overpass, a small proportion of the local bat population will inevitably fly over the proposed road development and be vulnerable to vehicle collisions. A small proportion of the population will also be adversely affected by the barrier effect posed by the proposed road development across the landscape. The effect of this residual impact on Lesser horseshoe bats is predicted to be significant at a national geographic scale. The impact on other bat species is predicted to be significant at a local geographic scale

These residual impacts have been addressed further by the proposal for specific compensatory measures.

8.7.4.3 Badger

A mitigation strategy will be implemented (and monitored) during construction to ensure that the removal of badger setts and the predicted disturbance to Badger that will occur during construction does not contravene the protection afforded to the breeding and resting places of wild animals (including Badger) under Section 23 (5)(d) of the Wildlife Acts (**Section 8.6.7.3.1**).

Mitigation measures will be implemented (and monitored) to ensure that, during operation, the proposed road development does not result in a significant negative effect on the local Badger population as a result of severance/barrier effects or mortality risk: the provision of mammal passage facilities in conjunction with mammal resistant fencing (**Section 8.6.7.3.2**).

Therefore, the proposed road development will not result in a likely significant negative residual effect on Badger, at any geographic scale.

8.7.4.4 Other Mammal Species

A mitigation strategy will be implemented to minimise the risk of the proposed road development affecting water quality in receiving watercourses/waterbodies during construction which will ensure that there is not a significant negative effect on local aquatic or marine mammal populations (**Section 8.6.7.4.1**).

Mitigation measures will be implemented to ensure that, during operation, the proposed road development does not result in a significant negative effect on local mammal populations (excluding bats) as a result of severance/barrier effects or mortality risk: the provision of mammal passage facilities in conjunction with mammal resistant fencing (**Section 8.6.7.4.2**).

Therefore, the proposed road development will not result in a likely significant negative residual effect on any other mammal species (excluding bats), at any geographic scale.

8.7.5 Invertebrates

8.7.5.1 White-clawed crayfish

As there are no records of White-clawed crayfish from within the ZoI of the proposed road development they will not be affected. Therefore, no mitigation measures are required and no residual impacts are predicted.

8.7.5.2 Freshwater pearl mussel

As there are no records of Freshwater pearl mussel from within the ZoI of the proposed road development they will not be affected. Therefore, no mitigation measures are required and no residual impacts are predicted.

8.7.5.3 Marsh whorl snail

A mitigation strategy will be implemented during construction to minimise the risk of the proposed road development affecting water quality in receiving watercourses/waterbodies and to ensure that the existing groundwater regime is not affected. This will ensure that there is not a significant negative impact on the habitats supporting the Marsh whorl snail during construction (**Section 8.6.8.1.1**).

Mitigation measures will be implemented to ensure that the existing groundwater regime is not affected during operation (**Section 8.6.8.1.2**).

Therefore the proposed road development will not result in a likely significant negative residual effect on the Marsh whorl snail, at any geographic scale.

8.7.5.4 Marsh fritillary

A mitigation strategy will be implemented during construction to avoid any Marsh fritillary mortality during site clearance works (**Section 8.6.8.2.1**). No other likely significant effects on the Marsh fritillary butterfly are predicted during construction.

No likely significant negative effects on Marsh fritillary are predicted during operation and no mitigation measures are required.

Therefore the proposed road development will not result in a likely significant negative residual effect on the Marsh fritillary butterfly, at any geographic scale.

8.7.6 Birds

8.7.6.1 Breeding birds

A mitigation strategy will be implemented during construction to minimise the mortality risk and the effects of habitat loss and disturbance to breeding birds (**Section 8.6.9.1.1**). This includes retaining the ledge used as the Peregrine falcon nest site between 2015 and 2017 within the design and a seasonal restriction on construction works in the vicinity of the nest site.

A mitigation strategy will be implemented (and monitored) to minimise the mortality risk to the local Barn owl population posed by the proposed road development during operation (**Section 8.6.9.1.2**). This includes the provision of additional nesting structures and planting to discourage Barn owl from foraging along the proposed road carriageway.

Therefore, the proposed road development will not result in a likely significant negative residual effect on breeding bird species, at any geographic scale, with the exception of the Peregrine falcon. Due to the likely permanent loss of Lackagh Quarry as a nesting site, the proposed road development is likely to result in a significant negative residual effect on Peregrine falcon, at the county geographic scale.

8.7.6.2 Wintering birds

A seasonal restriction on blasting near Ballindooley Lough will ensure that there are no long-term effects on wintering bird populations from construction works associated with the proposed road development (**Section 8.6.9.2**).

No likely significant negative effects on wintering bird species are predicted during operation, and no mitigation measures are required.

Therefore the proposed road development will not result in a likely significant negative residual effect on wintering bird species, at any geographic scale.

8.7.7 Amphibians

A mitigation strategy will be implemented during site clearance works to minimise the risk of the proposed road development affecting water quality in receiving watercourses/waterbodies, to minimise the mortality risk, and to minimise the effects of habitat loss and disturbance, on the local Common frog and Smooth newt populations. This will ensure that construction of the proposed road development will not have any long-term effects, or affect the conservation status, of these amphibian species. It will also ensure that site clearance works will not contravene the protection afforded to the breeding and resting places of wild animals (including the Common frog and Smooth newt) under Section 23 (5)(d) of the Wildlife Acts (**Section 8.6.10.1**).

The design of the proposed road development, in conjunction with the network of mammal passage facilities, will ensure that there are no long-term severance or barrier effects to the local Common frog and Smooth newt populations associated with the proposed road development (**Section 8.6.10.2**).

Therefore the proposed road development will not result in a likely significant negative residual effect on the Common frog or the Smooth newt, at any geographic scale.

8.7.8 Reptiles

A mitigation strategy will be implemented during site clearance works to minimise the mortality risk, and to minimise the effects of habitat loss and disturbance, on the local Common lizard population. This will ensure that construction of the proposed road development will not have any long-term effects, or affect the conservation status, of the Common lizard. It will also ensure that site clearance works will not contravene the protection afforded to the breeding and resting places of wild animals (including the Common lizard) under Section 23 (5)(d) of the Wildlife Acts (**Section 8.6.11.1**).

The design of the proposed road development, in conjunction with the network of mammal passage facilities, will ensure that there are no long-term severance or barrier effects to the local Common lizard population associated with the proposed road development (**Section 8.6.11.2**).

Therefore the proposed road development will not result in a likely significant negative residual effect on the Common lizard, at any geographic scale.

8.7.9 Fish

In conjunction with the design of the proposed road development, mitigation measures will be implemented to minimise the effects of habitat loss on fish species, and to maintain fish passage along all watercourses crossed by the proposed road development, such that no population level effects are predicted (**Section 8.6.12.1**).

A mitigation strategy will be implemented during construction to minimise the risk of the proposed road development affecting water quality in receiving watercourses/waterbodies and to ensure that the existing groundwater regime is not affected. This will ensure that there is not a likely significant negative effect on fish species during construction (**Section 8.6.4**).

Mitigation measures will also be implemented to minimise the potential for disturbance or mortality of fish species during construction, such that no population level effects are predicted.

No likely significant negative effects on fish species are predicted during operation, and no mitigation measures are required.

Therefore the proposed road development will not result in a likely significant negative residual effect on fish species, at any geographic scale.

8.7.10 Local Biodiversity Areas

All of the local biodiversity areas impacted by the proposed road development will be affected to some degree by the likely significant effects associated with the proposed road development on the KERs that have been identified in each of those areas. These likely significant effects are accounted for, and described, above separately and this section provides some context for these residual impacts with respect to the locations of the local biodiversity area through which the proposed road development passes.

The residual impact of the loss of c.0.01ha of Residual alluvial forest [*91E0] habitat will have a residual impact on the Menlough to Coolough Hill local biodiversity area. The residual impact associated with this habitat loss has been assessed as significant at the international geographic scale.

The residual impact of the loss of c.0.54ha of Limestone pavement [*8240] habitat will have a residual impact on the Menlough to Coolough Hill local biodiversity area and the Doughiska local biodiversity area. The residual impact associated with this habitat loss has been assessed as significant at the international geographic scale.

The residual impact of the loss of c.4.78ha of peatland habitat mosaic (Wet heath [4010], Dry heath [4030] and *Molinia* meadow [6410]) will have a residual impact on the Coast Road (R336) to the N59 Moycullen Road local biodiversity area. The residual impact associated with this habitat loss has been assessed as significant at the national geographic scale.

The residual impact of the loss of c.0.7ha of Calcareous grassland [6210] habitat will have a residual impact on the Menlough to Coolough Hill local biodiversity area and the Doughiska local biodiversity area. The residual impact associated with this habitat loss has been assessed as significant at the national geographic scale.

The residual impact of the loss of c.0.28ha of *Molinia* meadow [6410] habitat will have a residual impact on the Ballindooley – Castlegar local biodiversity area. The residual impact associated with this habitat loss has been assessed as significant at the national geographic scale.

The residual impact of the loss of the calcareous springs (FP1) and the Petrifying springs [*7220] at Lackagh Quarry will have a residual impact on the Menlough to Coolough Hill local biodiversity area. The residual impact associated with this habitat loss has been assessed as significant at the local and county geographic scales, respectively.

The residual impact of the loss of c.7.81ha of dry-humid acid grassland (GS3) and c.0.13ha of Poor fen and flush habitat (PF2) will have a residual impact on the Coast Road (R336) to the N59 Moycullen Road local biodiversity area. The residual impact associated with this habitat loss has been assessed as significant at the local geographic scale.

Hedgerows and treelines will be impacted throughout the local area with the greatest concentrations affected in parts of the Coast Road (R336) to the N59 Moycullen Road local biodiversity area around Ballagh, in the Menlough to Coolough Hill local biodiversity area, and in the Doughiska local biodiversity area. The residual impact associated with this habitat loss has been assessed as significant at the local geographic scale.

The residual impact of the loss of Broadleaved woodland (WD1) and Oak-ash-hazel woodland (WN2) will have a residual impact on the Menlough to Coolough Hill local biodiversity area. The residual impact associated with this habitat loss has been assessed as significant at the local geographic scale.

The residual impact on the local Lesser horseshoe bat population will have a residual impact principally on the Menlough to Coolough Hill local biodiversity area, but is also likely to affect the River Corrib and the Coolagh Lakes local biodiversity area and the Ballindooley – Castlegar local biodiversity area. This residual impact associated has been assessed as potentially significant at the national geographic scale.

The residual impact on all other bat species recorded within the study area will have a residual impact on the Coast Road (R336) to the N59 Moycullen Road local biodiversity area, the River Corrib and the Coolagh Lakes local biodiversity area, the Menlough to Coolough Hill local biodiversity area, the Ballindooley – Castlegar local biodiversity area, and the Doughiska local biodiversity area. This residual impact associated has been assessed as significant at the local geographic scale.

The residual impact on the local Peregrine falcon population will have a residual impact on the Menlough to Coolough Hill local biodiversity area. This residual impact associated has been assessed as significant at the county geographic scale.

The residual impacts of the proposed road road development, as they relate to each of the local biodiversity area, are summarised below:

- Coast Road (R336) to the N59 Moycullen Road local biodiversity area
- Residual impact at the national geographic scale

  Peatland habitat mosaic (Wet heath [4010], Dry heath [4030] and *Molinia* meadow [6410])

- Residual impact at the local geographic scale

  Dry-humid acid grassland (GS3), Poor fen and flush habitat (PF2), Hedgerows and treelines (WL1/WL2), bats other than the Lesser horseshoe bat

River Corrib and the Coolagh Lakes local biodiversity area

- Residual impact at the national geographic scale

  Lesser horseshoe bat

- Residual impact at the local geographic scale

  Bat species other than the Lesser horseshoe bat

Menlough to Coolough Hill local biodiversity area

- Residual impact at the international geographic scale

  Limestone pavement [*8240] and Residual alluvial forest [*91E0]

- Residual impact at the national geographic scale

  Calcareous grassland [6210] and the Lesser horseshoe bat

- Residual impact at the county geographic scale

  Petrifying springs [*7220] and the Peregrine falcon

- Residual impact at the local geographic scale

  Calcareous springs (FP1), Broadleaved woodland (WD1), Hedgerows and treelines (WL1/WL2), Oak-ash-hazel woodland (WN2) and bats other than the Lesser horseshoe bat

Ballindooley – Castlegar local biodiversity area

- Residual impact at the national geographic scale

  Molinia meadow [6410] and the Lesser horseshoe bat

- Residual impact at the local geographic scale

  Bats other than the Lesser horseshoe bat

Doughiska local biodiversity area

- Residual impact at the international geographic scale

  Limestone pavement [*8240]

- Residual impact at the national geographic scale

Calcareous grassland [6210]

- Residual impact at the local geographic scale

  Hedgerows and treelines (WL1/WL2) and bats other than the Lesser horseshoe bat

8.8 Cumulative Impacts

This section of the report presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on biodiversity.

The projects which are either in place, or proposed, which are considered in assessing the potential for cumulative impacts to increase the significance of the impacts predicted for the proposed road development on biodiversity are as follows:

- Galway Transport Strategy (GTS)
- M17 Galway to Tuam Road Project
- N18 Oranmore to Gort Road Project
- N83 Tuam Bypass
- M6 Motorway
- M6 (M17/M18) Motorway Service Area
- N59 Clifden to Maam Cross Road Project (objective in the *Galway County Development Plan 2015-2021*)
- N59 Maam Cross to Oughterard Road Project
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project
- Galway to Dublin Cycleway
- Connemara Greenway (from Galway City to Clifden))
- Galway to Spiddal Greenway (Bearna to Spiddal Cycleway)
- R336 Bearna to Scríb via Ros an Mhíl Upgrade/Improvement (objective in the *Galway County Development Plan 2015-2021*)
- Sáilín to Silverstrand Coastal Protection Scheme
- Salthill Coastal Protection Works (Blackrock to Galway Golf Club)
- Proposed Galway Harbour Port Extension

The potential for other plans or projects to act cumulatively with the proposed road development to adversely affect the integrity of any European sites, is considered in Section 12 of the NIS (termed “in combination effects” in the context of the NIS assessment). The four European sites within the ZoI of the proposed road development are Lough Corrib cSAC, Galway Bay Complex cSAC, Lough Corrib SPA and Inner Galway Bay SPA. There is no potential for any other projects to act in combination with the proposed road development to adversely affect the integrity of any other European sites, as they are beyond the ZoI of the proposed road development.

The in combination assessment identified those plans and projects which have the potential to impact on Lough Corrib cSAC, Galway Bay Complex cSAC, Lough Corrib SPA and Inner Galway Bay SPA and assessed whether they had the potential to adversely affect the integrity of these European sites. Any plan or proposed project that could potentially affect these European sites in combination with the proposed road development must adhere to the overarching policies and objectives of the relevant land use plan(s), as dependent on the location of the specific plan or proposed project. These are the *Galway County Development Plan 2015-2021*, the *Galway City Council Development Plan 2017-2023*, the *Clare County Development Plan 2017-2022* and the *Mayo County Development Plan 2014-2020*[97]. The protective policies and objectives in these land use plans will ensure the protection of European sites across the identified potential impact pathways.

As the proposed road development will not affect the integrity of Lough Corrib cSAC, Galway Bay Complex cSAC, Lough Corrib SPA or Inner Galway Bay SPA, and given the protection afforded to European sites under the overarching land use plans, it was concluded that there is no potential for adverse effects on the integrity of any European sites to arise as a consequence of the proposed road development acting in combination (or cumulatively) with any other plans or projects.

The potential for cumulative impacts to arise are limited to those residual impacts associated with the proposed road development and those effects the proposed road development will have on the receiving environment that are measurable in some way, but themselves will not result in a likely significant residual effect on biodiversity.

The residual impacts associated with the proposed road development relate to the following:

- Habitat loss, including both the permanent loss of Annex I habitats and habitats valued as being of local importance
- The potential loss of a Peregrine falcon nest site due to long-term disturbance/displacement impacts
- Impacts on bats as a result of the construction and operation of the proposed road development

The other impacts associated with the proposed road development that are measurable in some way, but themselves will not result in a likely significant effect on biodiversity and these are also discussed below:

- Impacts on the existing hydrological and hydrogeological regimes

[97] Although the regional and national level Plans sit above the county and local plans in the hierarchy (e.g. Project Ireland 2040 – National Planning Framework and the Regional Planning Guidelines for the West Region 2010-2022), the NPF is given effect at a regional level by the RDP and projects to meet its aims will be implemented locally by the relevant local authority and must comply with the statutory planning requirements, and must be in accordance with the objectives and policies of the relevant land use plans (Development Plans, Local Area Plans etc.).

- Impacts on air quality
- Impacts to species as a result of disturbance or displacement

Impacts from habitat loss

As outlined in **Section 8.5.2**, habitat loss to development and land use change has been an ongoing impact locally which may have already had effects on local biodiversity. Those projects listed above have, or are likely to, result in habitat impacts (including those of a high biodiversity value such as Annex I habitat types) which may also have knock-on effects on fauna species. Therefore, land use change and habitat losses are likely to continue to some degree and the loss and fragmentation of habitat associated with the proposed road development will contribute to this trend locally.

The most notable habitat loss impacts are the losses of areas of internationally or nationally valued habitats: Limestone pavement [*8240], Residual alluvial forest [*91E0], Wet heath [4010], Dry heath [4030], Calcareous grassland [6210], *Molinia* meadow [6410] and a Petrifying spring [*7220]. There are also significant areas of habitat types of a local biodiversity value that will be lost: calcareous springs, reed and large sedge swamps, dry-humid acid grassland, poor fen and flush, broadleaved woodland, hedgerows and treelines. Habitat losses, regardless of their own habitat value, also have the potential to have an effect on the local fauna populations that they support. The most significant impact in that regard are the likely effects of habitat loss on the local bat populations; particularly the Menlo Castle Lesser horseshoe bat population (impacts on bats are discussed separately below).

The losses of areas of Annex I habitat associated with the proposed road development are considered to be at the highest level of geographic significance for the habitats involved. In addition, the proposed road development will be contributing to an existing trend of Annex I habitat loss locally. While the cumulative effect of habitat losses would increase the magnitude of the impact, it does not increase the geographic scale of the impact significance associated with the proposed road development. The protective polices in the *Bearna Local Area Plan 2007-2017*, the *Galway City Council Development Plan 2017-2023* and the *Galway County Development Plan 2015-2021* to protect biodiversity will moderate any future impacts on biodiversity, including those related to Annex I habitat types. Where the losses can be compensated for (see **Section 8.9** below), this offsets the contribution of the proposed road development to existing losses of the habitat type in question whilst ensuring that there is no potential for other developments to result in a significant cumulative impact.

In relation to areas of locally important habitats that will be lost, given the habitat types involved and that at any greater geographic scale they are likely to remain in a favourable conservation condition, any cumulative losses of these habitat types are not likely to increase the impact significance. The protective polices in place in the land use plans will also moderate any future losses of habitats of a biodiversity value. Where habitat losses can be compensated for this would also reduce the impact significance and the potential for any cumulative impacts with any future developments.

Impacts on Peregrine falcon

Due to the potential for long-term disturbance and displacement of the Lackagh Quarry Peregrine falcon pair from the existing nest site, the proposed road development is likely to result in a significant negative residual effect on Peregrine falcon, at the county geographic scale.

The two other Peregrine falcon nest sites that are present locally are likely to continue to support breeding Peregrine falcon. One site is a disused quarry which is zoned for agricultural use and is therefore, not likely to see any increased disturbance from development; the second nest site is a regularly occupied site in an active quarry and the baseline levels of disturbance, to which the resident Peregrine pair are habituated, are likely to remain. Neither of these sites are likely to be affected by any of the projects listed above, given their locations relative to where those strategies/projects will be implemented. Existing pressures at the county level on suitable nest site availability are expected to continue and may act cumulatively at the county geographic scale, but there isn't sufficient data available to quantify this. However, any additional pressures on the Peregrine falcon population will not increase the overall significance of the impact of the proposed road development to a national level impact given that the species is currently considered to be of a low conservation concern for its national population.

Therefore, there are no other projects that are likely to cumulatively act along with the proposed road development to increase the predicted impact significance of the proposed road development on Peregrine falcon from the likely significant negative residual effect, at the county geographic scale.

Impacts on bats

There are predicted residual impacts on bats include loss of roosts, loss of foraging habitat and the barrier/severance effect posed by roads.

Some proportion of existing roost sites in the vicinity of the proposed road development may deteriorate over time and become unsuitable for bats to use (e.g. derelict structures and old trees). Therefore, the roost sites that will be affected by the proposed road development could potentially contribute to such natural declines in other roost sites locally.

Loss of foraging habitat and barriers to bat movements may result from development of zoned land within the northern fringes of Galway City. Lands used by bats which are also zoned for development include light industrial zoning (C2.1) near the N84 Headford Road and Ballindooley, which may affect the proposed artificial roost via increased light spill. The recreation and amenity zoning at NUIG may also interact with the flight paths of bats moving between the Aughnacurra roosts and Menlo Castle and the use of those lands by foraging bats (e.g. where additional lighting may be proposed in the future). However, all of these impacts would be controlled by the assessment of individual planning applications which would consider the effects on protected species such as bats as part of their appraisal by the competent authority, having regard to the protective environmental policies outlines in the *Bearna Local Area Plan 2007-2017*, the *Galway City Council Development Plan 2017-2023*, the *Galway County Development Plan 2015-2021* and the *Ardaun Local Area Plan 2018-2024* to protect biodiversity[98]. Therefore, there are no additional cumulative impacts predicted regarding loss of foraging habitat or from barriers to bat movement.

Impacts on the existing hydrological or hydrogeological regimes

The proposed road development will not have any residual impacts on the existing hydrological regime in those surface water catchments crossed by the proposed road development or the receiving marine environment in Galway Bay, either through affecting existing flow conditions or affecting flooding regimes. The proposed road development will also not have any residual impact on the existing hydrogeological regime.

All of the surface water catchments, the groundwater bodies and the transitional waters of Galway Bay lie within the proposed National River Basin District; what was formerly the Western River Basin District (WRBD)[99]. The *River Basin Management Plan for the Western River Basin District in Ireland (2009-2015)*, and the current draft of the *The River Basin Management Plan for Ireland (2018-2021)*, aims to protect all waters within the district and, where necessary, improve waters and achieve sustainable water use. The purpose of the River Basin Management Plan is to reduce pollution levels, to restore good water quality status and to prevent deterioration in water quality in the river basins and groundwater bodies. There are many land use plans and projects that lie within the WRBD that have the potential to affect surface water and groundwater bodies. However, all of the overarching land use plans have environmental protective policies to protect the existing surface water and groundwater network.

Therefore, there are no other plans or projects that are likely to result in a significant effect on biodiversity, cumulatively with the proposed road development, as a consequence of surface water or groundwater impacts.

Impacts on air quality

There will be some change in air quality in the immediate vicinity of the proposed road development during operation, although it will not in itself result in a likely significant effect on biodiversity. The potential for cumulative impacts to occur through air quality effects is limited to the receiving environment in the immediate vicinity of the proposed road development and any future developments that would introduce air quality pollutants to this local area. There are no current or proposed projects that would be likely to contribute to the air quality baseline in any notable way in the vicinity of the proposed road development. Considering the land use zonings and objectives that relate to this area in the *Bearna Local Area Plan 2007-2017*, the *Galway City Council Development Plan 2017-2023*, the *Galway County Development Plan 2015-2021* and the *Ardaun Local Area Plan 2018-2024*, and the protective policies and objectives in both the *Galway City Council Development*

[98] For example, Policy 4.2 of the *Galway City Council Development Plan 2017-2023* which states "Protect and conserve rare and threatened flora and fauna and their key habitats, (wherever they occur) listed on Annex I and Annex IV of the EU Habitats Directive (92/43EEC) and listed for protection under the Wildlife Acts 1976-2000."

[99] For the next cycle of river basin management plans (2018-2021) the Eastern, South Eastern, South Western, Western and Shannon River Basin Districts will be merged to form one national River Basin District

Plan 2017-2023 and the overarching *Galway County Development Plan 2015-2021* to protect air quality and biodiversity, there are no other plans or projects that are likely to result in a significant effect on biodiversity, cumulatively with the proposed road development, as a consequence of air quality impacts.

Impacts on fauna species (excluding bats) as a result of disturbance or displacement

The proposed road development will not result in a likely significant residual effect on any fauna species (excluding bats) as a result of disturbance or displacement effects during either construction or operation.

Disturbance or displacement impacts during construction are temporary or short-term and are not likely to have long-term population level effects, even cumulatively with any future development projects that might be proposed.

During operation, the predicted ZoI from the proposed road development is limited to the immediate vicinity and will not result in a likely significant residual effect on any fauna species (excluding bats) as a result of disturbance or displacement effects. Considering the land use zonings in the areas through which the proposed road development passes (predominantly rural fringe, recreational amenity, amenity and agri-amenity), and the minimal effect of operational disturbance from road traffic, and the abundance of alternative suitable habitat locally to support those fauna species present, future development is not likely to result in in a significant effect on biodiversity, cumulatively with the proposed road development, as a consequence of disturbance or displacement impacts.

8.8.1 Summary of Residual Impacts

Table 8.39 below presents an overall summary of the likely significant effects of the proposed road development on biodiversity, in consideration of the mitigation measures.

Table 8.39: Summary of Likely Significant Residual Effects of the Proposed Road Development on Biodiversity (including mitigation)

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
Designated Areas for Nature Conservation					
Lough Corrib cSAC (including Lough Corrib pNHA)	International (National)	**Construction** Habitat loss Habitat degradation – tunnelling/excavation Habitat degradation – hydrogeology Habitat degradation – hydrology Habitat degradation – air quality Habitat degradation – non-native invasive plant species Mortality risk **Operation** Habitat degradation – hydrogeology Habitat degradation – non-native invasive plant species Mortality risk	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect
Galway Bay Complex cSAC (including Galway bay Complex pNHA)	International (National)	**Construction** Habitat degradation – hydrology Habitat degradation – non-native invasive plant species Barrier effect Mortality risk	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
Lough Corrib SPA (including Lough Corrib pNHA)	International (National)	**Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology Disturbance/displacement **Operation** Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect
Inner Galway Bay SPA including Galway bay Complex pNHA)	International (National)	**Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology Disturbance/displacement **Operation** Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect
Moycullen Bogs NHA	National	**Construction** Habitat degradation – air quality Habitat degradation – non-native invasive plant species Habitat degradation – hydrology **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale	Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5** Water quality during construction – **Section 8.6.4**	No likely significant residual effect

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
Habitats (outside of designated areas for nature conservation)					
Limestone pavement [*8240]	International Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the international geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant residual effect at the international geographic scale
Petrifying springs [*7220]	International Importance	**Construction** Habitat loss	Likely significant effect at the county geographic scale (see **Section 8.5.4.3** under petrifying springs)	To reduce the scale of habitat loss – see **Section 8.6.2.1**	Likely significant residual effect at the county geographic scale (see **Section 8.7.2**)
Calcareous grassland [*6210/6210]	International/National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale (No *6210 affected – see **Section 8.5.4.3**	To reduce the scale of habitat loss – see **Section 8.6.2.1**	Likely significant residual effect at the national geographic scale

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
		Operation Habitat degradation – non-native invasive plant species	under Calcareous grassland))	Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	(see **Section 8.7.2**)
Dry heath [4030]	National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant residual effect at the national geographic scale (see **Section 8.7.2**)
Wet heath [4010][100]	National Importance	**Construction** Habitat loss Habitat degradation – air quality	Likely significant effect at the national geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1**	Likely significant residual effect at the national

[100] Including areas of Wet heath/Dry heath/*Molinia* meadow [4010/4030/6410] mosaic

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
		Habitat degradation – groundwater **Operation** Habitat degradation – groundwater		Air quality during construction – **Section 8.6.3** Groundwater during construction and operation – **Section 8.6.5**	geographic scale (see **Section 8.7.2**)
Molinia meadow [6410]	National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction – **Section 8.6.3** Groundwater during construction and operation – **Section 8.6.5**	Likely significant residual effect at the national geographic scale (see **Section 8.7.2**)
Residual alluvial forest [*91E0]	International Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the international geographic scale	Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant residual effect at the international geographic scale (see **Section 8.7.2**)

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
Turloughs [*3180]	International Importance	**Construction** Habitat loss Habitat degradation – surface water quality Habitat degradation – groundwater Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – groundwater Habitat degradation – non-native invasive plant species	Likely significant effect at the international geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction – **Section 8.6.3** Water quality during construction – **Section 8.6.4** Groundwater during construction and operation – **Section 8.6.5** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	No likely significant residual effect
Hard water lakes [3140]	National Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the national geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
Mesotrophic lakes (FL4) *Part of Ballindooley complex*	County Importance[101]	**Construction** Habitat degradation – surface water quality	Likely significant effect at the county geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect
Eutrophic lakes (FL5) *Part of Ballindooley complex*	County Importance[102]	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the county geographic scale	Water quality during construction – **Section 8.6.4** Groundwater during construction – **Section 8.6.5**	No likely significant residual effect
Calcareous springs (FP1) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1**	Likely significant residual effect at the local geographic scale
Cladium fen [*7210]	International Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the international geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect
Hydrophilous tall herb [6430]	International Importance	(see Lough Corrib cSAC above) **Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect

[101] On the basis that it forms part of the wetland complex at Ballindooley Lough
[102] On the basis that it forms part of the wetland complex at Ballindooley Lough

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
		Operation Habitat degradation – hydrogeology			
Alkaline fens [7230]	National Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the national geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect
Reed and large sedge swamps (FS1) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality	Likely significant effect at the local geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect
Tall-herb swamps (FS2) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect
Eroding/upland rivers (FW1)	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality	Likely significant effect at the local geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect
Depositing/lowland rivers (FW2) River Corrib	International Importance	The River Corrib forms part of see Lough Corrib cSAC (see above and NIS)	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect
Terryland River	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect
Drainage ditches (FW4)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
Marsh (GM1)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect
Dry calcareous and neutral grassland (GS1) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect
Dry meadows and grassy verges (GS2) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect
Dry-humid acid grassland (GS3) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant residual effect at the local geographic scale
Wet grassland (GS4) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect
Rich fen and flush (PF1) Non-Annex I habitat type	County Importance	**Construction** Habitat degradation – surface water quality Habitat degradation – air quality	Likely significant effect at the county geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
				Air quality during construction – **Section 8.6.3**	
Poor fen and flush (PF2) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality **Operation** Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Air quality during construction - **Section 8.6.3**	Likely significant residual effect at the local geographic scale
(Mixed) broadleaved woodland (WD1)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant residual effect at the local geographic scale
Mixed broadleaved/conifer woodland (WD2)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
(Mixed) conifer woodland (WD3)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect
Hedgerows (WL1)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant effect at the local geographic scale
Treelines (WL2)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction – **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant effect at the local geographic scale

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
Oak-ash-hazel woodland (WN2) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat degradation – air quality Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	No likely significant residual effect
Scrub (WS1) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect
Fauna Species					
Badger	Local Importance (Higher Value)	**Construction** Loss of breeding/resting sites Disturbance/displacement **Operation** Habitat severance/barrier effect Mortality risk	Likely significant effect at the local geographic scale	Measures to protect Badger during construction – **Section 8.6.7.3.1** Measures to protect Badger during operation – **Section 8.6.7.3.2**	No likely significant residual effect
Otter	International Importance	**Construction** Habitat degradation - water quality **Operation** Habitat severance/barrier effect	Likely significant effect at the local geographic scale	Measures to protect Otter during construction – **Section 8.6.7.1.1**	No likely significant residual effect

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
		Mortality risk		Measures to protect Otter during operation – **Section 8.6.7.1.2**	
Other mammal species protected under the Wildlife Acts	Local Importance (Higher Value)	**Construction** Habitat degradation - water quality **Operation** Habitat severance/barrier effect Mortality risk	Likely significant effect at the local geographic scale	Measures to protect other mammal species (excl. bats) during construction – **Section 8.6.7.3.1** Measures to protect other mammal species (excl. bats) during operation – **Section 8.6.7.3.2**	No likely significant residual effect
Lesser horseshoe bat	National Importance	**Construction** Roost loss Habitat loss Habitat fragmentation Disturbance/displacement **Operation** Mortality Barrier/severance effects Disturbance/displacement	Likely significant effect at the national geographic scale	Measures to protect bats during construction – **Section 8.6.7.2.1** Measures to protect bats during operation – **Section 8.6.7.2.2**	Likely significant effect at the national geographic scale
All other bat species	Local Importance (Higher Value)		Likely significant effect at the local geographic scale	Measures to protect bats during construction – **Section 8.6.7.2.1** Measures to protect bats during operation – **Section 8.6.7.2.2**	Likely significant effect at the local geographic scale

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
Marsh whorl snail	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater **Operation** Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Measures to protect the Marsh whorl snail during construction – **Section 8.6.8.1.1** Measures to protect the Marsh whorl snail during operation – **Section 8.6.8.1.2**	No likely significant residual effect
Marsh fritillary butterfly	County Importance	**Construction** Mortality risk	Likely significant effect at the local geographic scale	Measures to protect the Marsh fritillary butterfly during construction – **Section 8.6.8.2.1**	No likely significant residual effect
SCI bird species	International	*see Lough Corrib SPA and Inner Galway Bay SPA above*	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect
Barn owl	County Importance	**Operation** Mortality risk	Likely significant effect at the county geographic scale	Measures to protect breeding birds during operation – **Section 8.6.9.1.2**	No likely significant residual effect
Peregrine falcon	County Importance	**Construction** Disturbance/displacement **Operation** Disturbance/displacement	Likely significant effect at the county geographic scale	Measures to protect breeding birds during construction – **Section 8.6.9.1.1**	Likely significant residual effect at the county

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
				Measures to protect breeding birds during operation – **Section 8.6.9.1.2**	geographic scale
All other breeding bird species (non SCI)	Local Importance (Higher Value)	**Construction** Mortality risk Disturbance/displacement **Operation** Mortality risk Disturbance/displacement	Likely significant effect at the local geographic scale	Measures to protect breeding birds during construction – **Section 8.6.9.1.1** Measures to protect breeding birds during operation – **Section 8.6.9.1.2**	No likely significant residual effect
All other wintering bird species (non-SCI)	Local Importance (Higher Value)	**Construction** Disturbance/displacement (Ballindooley Lough) Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Measures to protect wintering birds during construction – **Section 8.6.9.2.1** Measures to protect wintering birds during operation – **Section 8.6.9.2.2**	No likely significant residual effect
Smooth newt Common frog	Local Importance (Higher Value)	**Construction** Habitat loss Disturbance & mortality risk Habitat degradation – surface water quality **Operation** Habitat severance/barrier effect	Likely significant effect at the local geographic scale	Measures to protect amphibians during construction – **Section 8.6.10.1** Measures to protect amphibians during	No likely significant residual effect

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
				operation – **Section 8.6.10.2**	
Common lizard	Local Importance (Higher Value)	**Construction** Habitat loss Disturbance & mortality risk **Operation** Habitat severance/barrier effect	Likely significant effect at the local geographic scale	Measures to protect reptiles during construction – **Section 8.6.11.1** Measures to protect reptiles during operation – **Section 8.6.11.2**	No likely significant residual effect
Atlantic salmon European eel	International Importance	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Measures to protect fish species during construction – **Section 8.6.12.1**	No likely significant residual effect
All other fish species recorded	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Measures to protect fish species during construction – **Section 8.6.12.1**	No likely significant residual effect
Local Biodiversity Areas					
Local biodiversity areas	The value of the biodiversity receptors recorded in the vicinity of the proposed road development, across the local	Combinations of all of the potential impacts noted above The specific impacts are related to and dependent upon the potential impacts of the proposed road development on each of the individual ecological receptors that make	Likely significant effects from local up to the international geographic scale	All of the mitigation measures included within **Section 8.6** The specific mitigation measures are related to and dependent upon the potential impacts of	Likely significant effects from local up to the international geographic scale

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance
	biodiversity areas, range from Local Importance (Lower Value) to Internationally Important	up the biodiversity resource within a given local biodiversity area		the proposed road development on each of the individual ecological receptors that make up the biodiversity resource within a given local biodiversity area	Refer to **Section 8.7.10** for breakdown by local biodiversity area

8.9 Compensation

Where there are significant residual biodiversity impacts as a result of the proposed road development, despite the mitigation measures proposed, compensatory measures are proposed to offset or reduce the predicted impacts[103]. These are not compensatory measures in the context of the requirements of Article 6(4) of the Habitats Directive as they are not compensating for an impact that would adversely affect the integrity of any European site. As concluded in the NIS, the proposed road development will not result in such an impact on any European site.

The likely significant residual effects of the proposed road development relate to habitat loss, the potential permanent loss of a Peregrine falcon nest site, and impacts on the local bat populations. Each of these are discussed below with regard to whether compensatory measures are feasible and likely to succeed in compensating for the potential impacts of the proposed road development.

8.9.1 Habitat loss

Limestone pavement [*8240] has a clint and gryke, or shattered pavement, structure which supports the vegetation characteristic of this habitat type. This underlying rock structure is created over millennia by geological and weathering processes and cannot be artificially recreated and is effectively a non-renewable habitat resource. Therefore, the losses of Limestone pavement habitat associated with the proposed road development cannot be compensated.

Petrifying springs [*7220] are a product of the interaction of groundwater and the underlying geology to create a tufa forming spring that supports the associated species assemblage to correspond to this priority Annex I habitat type. Such features cannot readily be artificially recreated with any degree of certainty and, as per Limestone pavement, are effectively a non-renewable habitat resource. Therefore, the loss of a Petrifying spring associated with the proposed road development cannot be compensated.

Wet heath [4010] is a habitat type that forms on shallow peats with impeded drainage. In the western part of the study area, this is due to the underlying bedrock and undulating topography retaining a water table near to the surface. Wet heath cannot readily be artificially recreated with any degree of certainty. Therefore, the loss of Wet heath associated with the proposed road development cannot be directly compensated.

The areas of Residual alluvial forest [*91E0], Dry heath [4030], Calcareous grassland [6210] and *Molinia* meadow [6410] that will be lost as a result of the proposed road development will be compensated. In each case the area of each habitat type being provided is greater than that being lost. In relation to Dry heath, the area of habitat being provided is greater than the combined losses associated with this habitat type and any Wet heath/*Molinia* meadow mosaics (c.4.78ha). Although this does not reduce the residual impact associated with the loss of Wet heath habitat, it is included in order to provide a biodiversity gain for peatland

[103] "Compensation describes measures taken to make up for residual effects resulting in the loss of, or permanent damage to ecological features despite mitigation" (CIEEM, 2016)

habitats in light of the fact that Wet heath cannot in itself be directly compensated for. This is summarised below in **Table 8.40**.

The full details of the Habitat Compensation Management Plan for each of the Annex I habitat types being compensated for, including monitoring, are presented in **Appendix A.8.26**. The areas where compensatory habitats will be created are shown on **Figures 8.23.1** to **8.23.14**.

In compensating for the losses of these habitat types, the proposed road development is not likely to result in a significant residual effect, at any geographic scale, on Residual alluvial forest [*91E0], Dry heath [4030], Calcareous grassland [6210] or *Molinia* meadow [6410].

Table 8.40: Summary of Residual PriorityAnnex I/Annex I habitat loss after compensation

Annex I habitat type	Permanent Area of Habitat Loss	Area of Compensatory Habitat Created	Residual Habitat Loss	Residual Impact Significance Post-compensation
Petrifying springs [*7220]	One Petrifying spring feature	n/a	One Petrifying spring feature	Likely significant residual effect at the county geographic scale
Residual alluvial forest [*91E0]	c.0.1ha	c.0.18ha	None	No likely significant residual effect
Limestone pavement [*8240]	c.0.54ha	n/a	c.0.54ha	Likely significant residual effect at the international geographic scale
Wet heath [4010]	c.2.06ha	n/a	c.2.06ha	Likely significant residual effect at the national geographic scale
Dry heath [4030]	c.1.85ha	c.7.06ha	None	No likely significant residual effect
Wet heath/Dry heath/*Molinia* mosaic [4010/4030/6410]	c.0.87ha	n/a	c.0.87ha[104]	Likely significant residual effect at the national geographic scale
Calcareous grassland [6210]	c.0.7ha	c.7.14ha	None	No likely significant residual effect

[104] Considered as Wet heath habitat for the purposes of the impact assessment, the loss of which cannot be directly compensated for.

Annex I habitat type	Permanent Area of Habitat Loss	Area of Compensatory Habitat Created	Residual Habitat Loss	Residual Impact Significance Post-compensation
Molinia meadow [6410]	c.0.28ha	c.0.49ha	None	No likely significant residual effect

There are a number of habitat types of a local biodiversity importance that will be permanently lost as a result of the proposed road development, and where significant residual negative effects are likely:

- Calcareous springs (FP1)
- Dry-humid acid grassland (GS3)
- Poor fen and flush (PF2)
- (Mixed) broadleaved woodland (WD1)
- Hedgerows (WL1)
- Treelines (WL2)

Of these, the planting proposed in the landscape design will compensate for the loss of the areas of (mixed) broadleaved woodland (WD1), hedgerows (WL1) and treelines (WL2) by providing a greater area to that being permanently lost to the proposed road development, as follows:

- (Mixed) broadleaved woodland (WD1) - > 2.62ha
- Hedgerows (WL1) - > 7.8km
- Treelines (WL2) - > 4km

In compensating for the losses of these habitat types, the proposed road development is not likely to result in a significant residual effect, at any geographic scale, on (mixed) broadleaved woodland (WD1), hedgerows (WL1) and treelines (WL2).

However, the proposed road development is likely to have a significant residual negative effect, at the local geographic scale, as a result of the permanent loss of fifteen Calcareous spring features (FP1), c.7.81ha of Dry-humid acid grassland (GS3) and c.0.13ha of Poor fen and flush habitat (PF2).

8.9.2 Bats

8.9.2.1 Compensation for loss of bat roosts

Loss of the more “significant” roosts (e.g. maternity roosts or roosts used by Lesser horseshoe bats) will be compensated by the erection of replacement structures (artificial roosts) in locations close to the original roost.

There is a dual purpose to the artificial roosts. Firstly, to ensure that there is no net loss of roosting opportunities for the bats confirmed to be roosting within the proposed development boundary. Secondly, it has been recognised that there will be an inevitable increase in mortality rates due to road collisions as suggested by scientific evidence (see **Section 8.5.6.2.2**). So the second function of the replacement roosts is to create improved conditions for bats to breed and to offset the likely increase in mortality.

Four artificial roost structures are proposed as set out below. The detailed fit-out of these artificial roosts will follow the recommendations of an experienced bat ecologist and further consultation with the Vincent Wildlife Trust will take place to ensure that their experiences in these techniques are taken into account.

Artificial roost structures will be screened from the effects of construction phase disturbance by means of solid hoarding or brushwood screens with an appropriate buffer zone around the roost. The dimensions of the planting will depend on the local topography and surrounding landscape and will be decided on a case-by-case basis by the bat ecologist.

It should be noted that the mitigation strategy, outlined above in **Section 8.6.7.2**, has included ensuring that passage underneath the proposed road development in the vicinity of the roosts has been facilitated by including culverts underneath the proposed road development in locations as close to the roosts as possible.

Proposed Aughnacurra maternity/hibernation roost for Lesser horseshoe bats and Brown long-eared bats

The proposed replacement roost will be located close to the existing Aughnacurra roost (PBR178) structure.

The proposed roost within the proposed development boundary will be screened with brushwood fencing or similar semi-solid screens c.2m high for the construction stage and will also be planted up around it as soon as the roost is constructed to provide long-term screening during the operation of the proposed road development. Non-native ornamental species may be used to provide screening in this case as it is in keeping with the suburban setting.

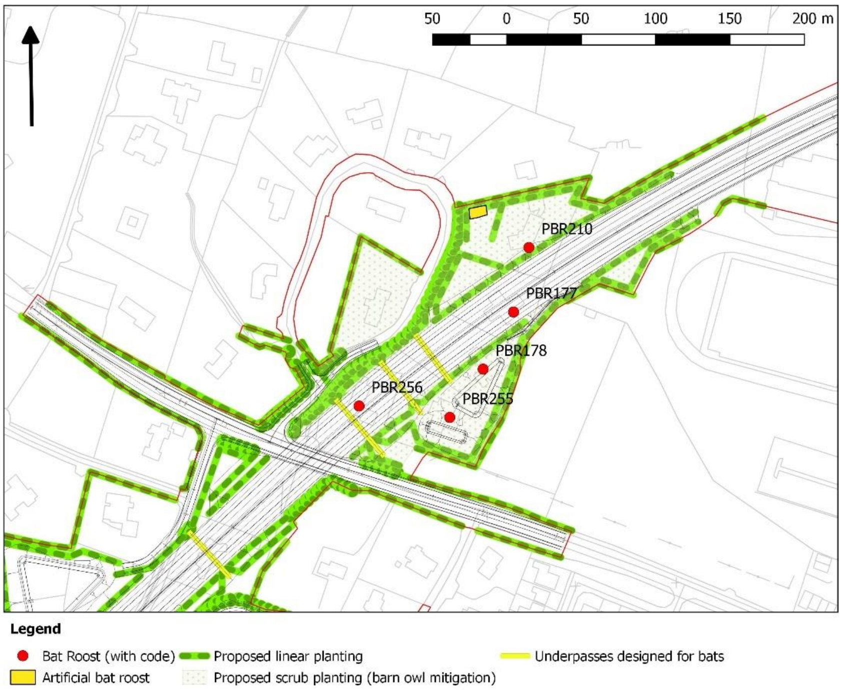
The design of the roost will take account of the Vincent Wildlife Trust (VWT) guidance[105] and will follow the following design parameters:

[105] Vincent Wildlife Trust (2015) *Lesser Horseshoe Bat: Conservation Handbook.*

- The template for the design will be taken from the roost at Garryland, Co. Galway constructed for the N18 Oranmore to Gort road development which has been shown to have worked successfully since its completion in 2011
- Single storey structure with southwest orientation for maximum solar gain on the pitched roof
- Location as set out in **Plate 8.5** below in corner of garden to be acquired
- Rendered block wall structure with natural slate roof. The exterior walls can be clad with rough stone or a material designed to have no adverse visual impact
- The building will have a footprint of c.10m x 8m with a steep pitched slate roof, partitions in the ground floor and roof space and an attic floor laid down with an open hatches for access for bats
- Plywood partitions will be installed within the roof voids to create bat "hotboxes" and separate roosting spaces for different species so that the brown long-eared bat roost can also be accommodated in the same building
- The interior of the roof should be lined with BS747 bituminous felt. All ceilings on the ground floor will be fitted with rough wood
- The entry point for bats shall be on the western side away from the proposed road development and close to the vegetation on the eastern perimeter which will be retained and enhanced. The entry point will be c.500mm x 300mm with bars set 125mm apart and lead flashing to be placed over the window sill under the hatch to prevent predator entry
- The northern corner will include a hibernation room at ground level which will be lined with concrete blocks and insulated to provide suitable conditions for hibernation. Plywood partitions will hang down from the ceiling to provide sheltered pockets at ceiling level. An earth floor will maintain humidity and some of the guttering will be piped inside to create an optional water-filled trough along one wall so that humidity levels can be adjusted if needed
- No water or electricity services are required
- Access for surveyors will be via a door on the southern side. Bats will be allowed to fly around the ground floor via an open hatch in the attic floor near the entry point

The proposed location (within the proposed development boundary) is close to vegetation which is important cover for bats entering and leaving. Additional planting is proposed to link the roost to the perimeter and to connecting features in the wider landscape.

Plate 8.5: Proposed location of Aughnacurra artificial roost structure (not to scale)



Menlo Castle alternative roost - Lesser Horseshoe maternity/hibernation roost

This roost is not replacing any specific loss of roost but is a critical part of the bat compensation measures. It will assist to increase the recruitment in the local Lesser horseshoe bat population so as to offset any increases in mortality as a result of the potential impacts of the proposed road development. The current roost in the chimney of the castle (PBR06) is likely to be unstable, inadequate and vulnerable to being lost if the castle falls into further disrepair. The new Menlo Castle roost would be better in design and aim to increase natural birth rates and thereby neutralise or overturn any negative impacts of the proposed road development. The preferred location is in a field to the east of the castle.

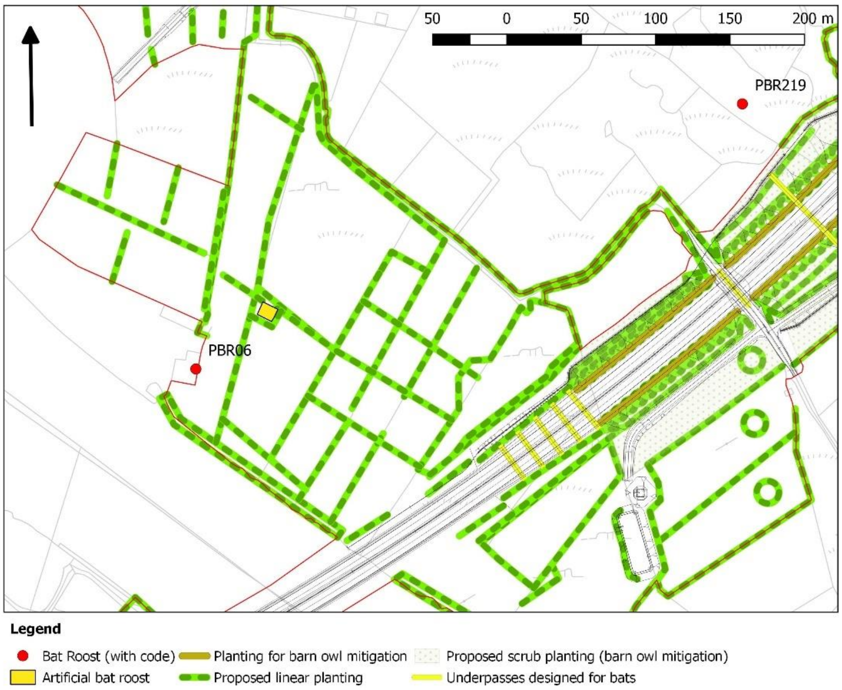
The design of the roost has taken account of the Vincent Wildlife Trust (VWT) guidance and following consultation with Dr Kate McAney and Ruth Hanniffy (VWT) and will follow the following design parameters:

- The template for the design will be taken from the roost at Garryland, Co. Galway constructed for the N18 Oranmore to Gort road development which has been shown to have worked successfully since its completion in 2011.
- Single storey structure with southern orientation for maximum solar gain on the pitched roof.
- Location as set out in **Plate 8.6** below in the northwest corner of the field close to Menlo Castle (PBR06).
- Rendered block wall structure with natural slate roof. The exterior walls can be clad with rough stone or a material designed to have no adverse visual impact.

Additional planting around the perimeter of the building will also screen it from view.

- The building will have a footprint of c.10m x 8m with a steep pitched slate roof, partitions in the ground floor and roof space and an attic floor laid down with an open hatches for access for bats. All ceilings on the ground floor will be fitted with rough wood.
- Plywood partitions will be installed within the roof voids to create bat “hotboxes” and separate roosting spaces for different species so that other bat species roost can also be accommodated in the same building.
- 4 no. wooden Kent bat boxes will be erected on the gable end of the structure to provide roosting opportunities for Daubenton’s and Pipistrelle bat species. See: http://www.bats.org.uk/publications_download.php/938/Kent_Bat_Box_Jul2013_copy.pdf
- The interior of the roof will be lined with BS747 bituminous felt or equivalent bituminous felt
- The entry point for bats shall be on the west gable end sides away from the proposed road development and close to the vegetation on the eastern perimeter which will be retained and enhanced. The entry point will be c.500mm x 300mm with bars set 125mm apart and lead flashing to be placed over the window sill under the hatch to prevent predator entry.
- The northern corner will include a hibernation room at ground level which will be lined with concrete blocks and insulated to provide suitable conditions for hibernation. Plywood partitions will hang down from the ceiling to provide sheltered pockets at ceiling level. An earth floor will maintain humidity and some of the guttering be piped inside to create an optional water-filled trough along one wall so that humidity levels can be adjusted if needed.
- No water or electricity services are required.
- Access for surveyors will be via a door on the southern side. Bats will be allowed to fly around the ground floor via an open hatch in the attic floor near the entry point.
- The proposed location within the proposed development boundary is close to vegetation which is important cover for bats entering and leaving. Additional planting is proposed to link the roost to the perimeter and to connecting features in the wider landscape.

Plate 8.6: Proposed location of Menlo Castle artificial roost structure

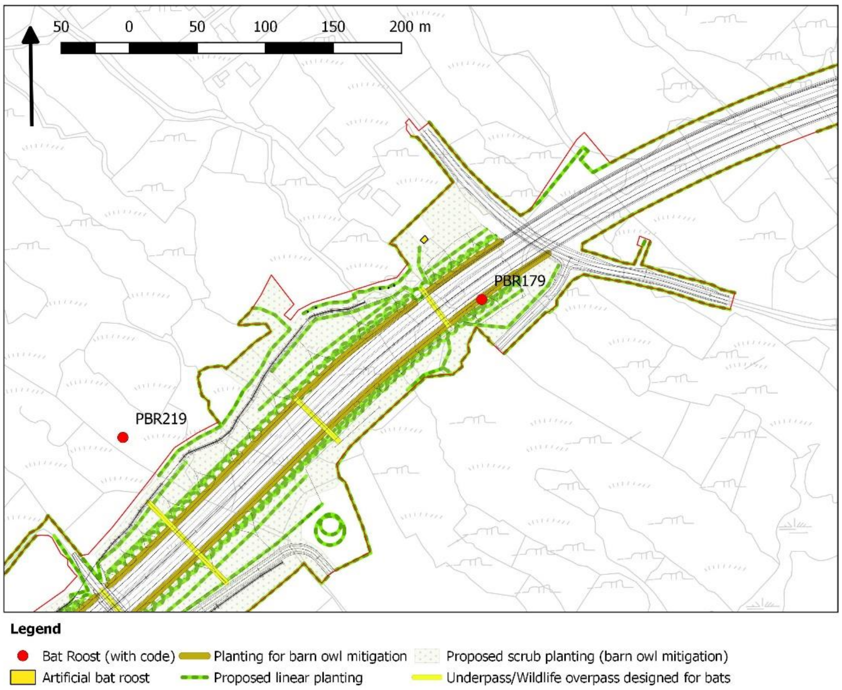


Menlough Woods Replacement Night roost for Lesser horseshoe bats and Soprano pipistrelle and Brown long-eared bats roosts

This is to replace a night roost for Lesser horseshoe bats (PBR219) and also replace roosts for Soprano pipistrelle bats (PBR179) and Brown long-eared bats (PBR179). It will be located near the edge of the proposed development boundary west of An Bóthar Nua and will be a simple wooden shed type structure (1m wide, 2.5m high, 2m deep). The footprint will be much smaller than the area indicated below on **Plate 8.7**. The design parameters include:

- Steep pitched slate roof facing southeast
- Plywood “ceiling” with access open hatch 300mm x 300mm for bats
- Access for bats via gap over access door 500mm x 500mm
- Access for birds prevented by installing plywood baffle 1m behind access gap
- Roof lined with BS747 bituminous felt

Plate 8.7: Proposed location of Menlough Woods artificial night roost structure



Ballindooley Night/Day roost for Brown long-eared and Pipistrelle bat and night/day/hibernation roost for Lesser horseshoe bats

This roost is to replace a Lesser horseshoe day/night roost on the N84 Headford Road (PBR and to replace roosts for Pipistrelle and Brown long-eared bats (PBR204, PBR182, PBR196). The structure will be a small block building (e.g. 6m x 8m footprint) with natural slate roof and some external features e.g. Kent bat boxes for use by other bats species.

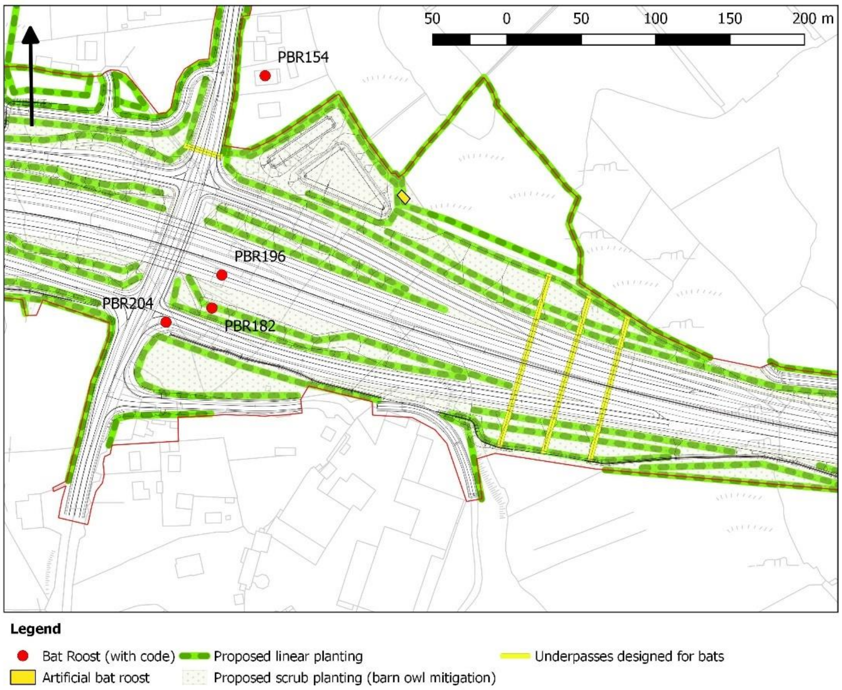
The design parameters include:

- Single storey structure with southwest orientation for maximum solar gain
- Location as set out in **Plate 8.8** below abutting the vegetation for good connections to foraging and shelter
- Rendered block wall structure with natural slate roof and can be clad and designed so as to have no adverse visual impact
- The building would have a footprint in the region of 6m x 8m with a steep pitched slate roof, partition wall in the ground floor and roof space and an attic floor laid down with an open hatch for access for bats[106]
- Plywood partitions may be installed within the roof voids to create bat "hotboxes" and separate roosting spaces for different species
- The interior of the roof should be lined with BS747 bituminous felt

[106] Vincent Wildlife Trust (2015) *Lesser Horseshoe Bat: Conservation Handbook.*

- Entry points for bats shall be on the east facing sides away from the proposed road development and close to the vegetation to the north which will be retained and enhanced
- The northern corner will include a hibernation room at ground level which will be lined with concrete blocks and insulated to provide suitable conditions for hibernation. Plywood partitions will hang down from the ceiling to provide sheltered pockets at ceiling level. An earth floor will maintain humidity and some of the guttering be piped inside to create an optional water-filled trough along one wall so that humidity levels can be adjusted if needed
- No water or electricity services are required
- Access for surveyors will be via a door on the southern side

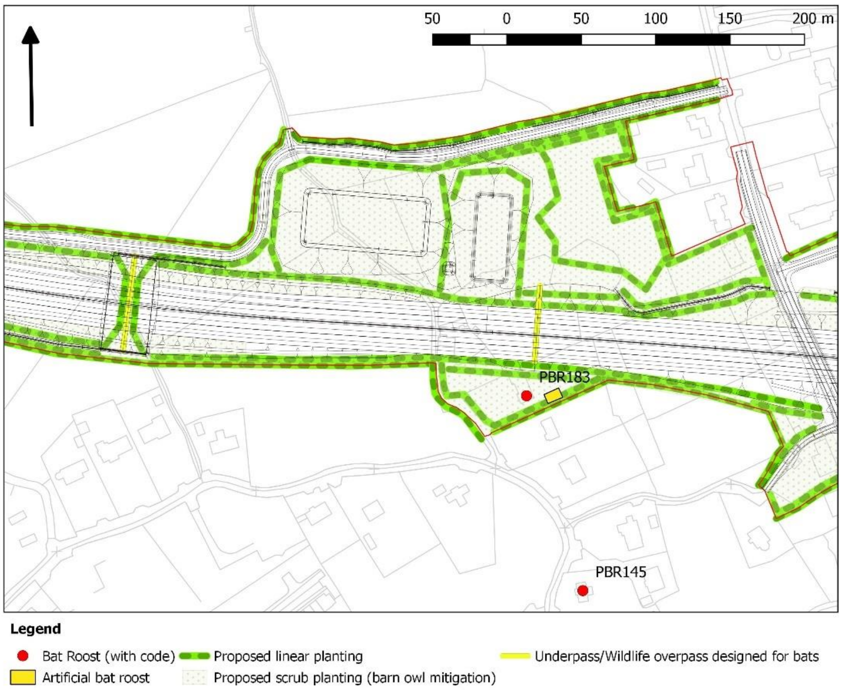
Plate 8.8: Proposed location of Ballindooley artificial night roost structure options



Retrofitting of Existing Structure

At Ch. 12+960 the detached converted garage (next to PBR183) to the south of the proposed road development to be retained and converted for use by several species including Brown long-eared bats and Lesser horseshoe bats. This building is in a strategically-important location as it will connect to the linear planting on the south side of the proposed road development and is just c.250m from the proposed Castlegar Wildlife Overpass in and within a local ecological corridor leading to Cooper's Cave, a proven hibernation and mating site for Lesser horseshoe bats. This structure will undergo minor interior and exterior modifications to create warm areas in the roof space for summer roosting and breeding and also cold conditions for hibernation. **Plate 8.9** shows this location below:

Plate 8.9: Retrofitted roost near PBR183, Castlegar



Bat Boxes

Bat boxes will preferably be located near the roosts to be lost but not immediately adjacent to the proposed road development where risk of collision with vehicles is highest.

Bat boxes will be erected by, or under the supervision of, a bat specialist.

These bat boxes will target Common and Soprano pipistrelle bats and Brown long-eared bats and will consist of Schwegler Type 1FF and 2FN bat boxes (or equivalent) as these have been demonstrated as being successful for these species in Ireland[107]. Mounting boxes on poles close to the edge of tree canopies will also allow the long-term retention of the boxes, as opposed to mounting boxes on small trees which have limited longevity.

A rocket box (as shown in **Appendix A.8.25** - see Drawing GCOB-3000-D-002 in Annex F of the bat derogation licence application) will be installed at Ch. 3+320 near the roost at PBR241, rather than a bat box fixed to the building itself, so as not to detract from its cultural heritage value.

Box locations, as shown on **Figure 8.24.1** to **8.24.15**, will include the following:

- Ch. 3+320: Rocket box to be erected to west of the building PBR241

[107] McAney K. and Hanniffy, R. (2015) *The Vincent Wildlife Trust's Irish Bat Box Schemes* http://www.mammals-in-ireland.ie/wp-content/uploads/2015/11/Ireland-Bat-Box-Project-Report-WEB.pdf

- Ch. 10+050: 5 boxes to be erected along the edge of the tree canopy near the underpass
- Ch. 11+400: 5 boxes to be erected on the entrance road into Lackagh Quarry
- Ch. 15+100: 5 bat boxes to be erected south of Galway Racecourse

In the case of bat boxes provided as replacements for bat tree roosts to be felled, boxes will be Schwegler Type 1F bat boxes (or equivalent) erected on suitable trees or structures retained within the proposed development boundary in the vicinity of the tree to be lost where possible. The type and siting of any bat boxes required will be determined by the bat specialist at that time but preliminary areas for bat boxes have been identified in the areas of woodland around Menlough, Coolough, on retained structures and the quarry walls at Lackagh Quarry and in areas near attenuation and infiltration ponds.

All new roosts, retrofitted structures and bat boxes will be erected in advance of the commencement of site clearance so that replacement roosts are available to bats and that there is reasonable chance that they will have discovered them prior to loss of the existing roost. Boxes can be erected at any time of year and preferably as soon as the necessary consents are in place for the proposed road development.

Protection of proposed artificial roosts during construction works

- Newly-created roosts and bat boxes within the proposed development boundary will be protected from the adverse effects of noise and lighting during the construction phase as it is an essential element of the mitigation strategy that they are accessible and usable by bats during this time
- All existing and proposed artificial roosts retained within the proposed development boundary will be surrounded with wooden panels to a height that allows shading and shelter of key roost access features
- Planting around the existing and proposed artificial roosts retained within the proposed road development will include fast growing shrub species, or fast-growing willow if the ground conditions permit. Planting will aim to guide bats away from the open construction zone toward linear features. Use of non-native species may be appropriate in some locations where it is important to get vegetation established
- All structures will be locked and not used for other purposes such as storage of materials or shelter
- The maintenance of the existing and proposed artificial roosts retained within the proposed development boundary, in a state that they are accessible and usable by bats, will be carried out by the Contractor until the completion of the proposed road development whereby it will be taken in charge by the local authority. Maintenance will include standard building repairs over time and responding to the results of the roost monitoring (e.g. increasing or reducing humidity)

8.9.2.2 Compensation for loss of foraging habitat

Approximately 7ha of woodland-pasture-hedgerow-scrub habitat will be removed from the area between the River Corrib and An Bóthar Nua in Menlough. This habitat is used by the Lesser horseshoe bat population and therefore there is a risk that there may be reduced breeding success if replacement planting is not made available.

An area of land has been identified which is within the known core foraging area of the Menlo Castle roost (PBR06) but is not optimal feeding habitat. It is composed of open fields of varying size used for low density cattle grazing. Hedgerows in this area will be augmented and thickets of hazel, hawthorn, holly and oak will be provided in several of the fields to create pockets of wood and grassland habitat. Grazing will continue on the lands as it has been shown that foraging over grazed land is preferred to ungrazed lands (Downes et al, 2016). Connectivity to foraging areas will also be secured through tying the proposed planting strips to hedgerows and woodland edges.

Planting of new hedgerows in fields between the proposed road development and Menlo Castle will improve the foraging resources of this core foraging area. Such planting will include an additional native hedgerows planted across the existing fields to increase the lengths of hedgerows close to the proposed new roost for Lesser horseshoe bats (refer to **Section 8.6.7.2**). The fields will still be grazed and the hedgerows can be fitted with field gates as required providing gaps are kept to a minimum.

The area of habitat enhancement for the purposes of offsetting the loss of suitable bat habitat due to the proposed road development amounts to approximately 8ha (refer to **Figure 8.24.7**).

8.9.2.3 Proposed Monitoring Programme

The monitoring programme described in **Section 8.6.7.2.3** above also relates to the compensation measures for bats described in this section.

8.9.3 Peregrine falcon

While artificial nest sites for Peregrine falcon can, and have been proven to, be successful, they require suitable cliff face or building of sufficient height at the proposed nest site. However, providing such nest sites does not guarantee that they will be taken up by either the Peregrine pair being displaced or occupied by another breeding pair in the future; particularly when they would likely be remote from the existing site, by at least a few kilometres, due to the topography of the surrounding land and the type and height of building structures nearby. Therefore, the potential loss of a Peregrine falcon nest site associated with the proposed road development cannot be compensated.

8.10 Summary

The proposed road development, despite the implementation of the mitigation and compensation measures proposed, will have the following likely significant residual effects on biodiversity:

- A likely significant residual effect, at the international geographic scale, for the permanent loss of c.0.54ha of the priority Annex I habitat Limestone pavement [*8240]
- A likely significant residual effect, at the national geographic scale, for the permanent loss of c.2.93ha of the Annex I habitat Wet heath [4010][108]
- A likely significant residual effect, at the county geographic scale, for the permanent loss of a Petrifying spring [*7220] feature at Lackagh Quarry
- A likely significant residual effect, at the county geographic scale, for the potential permanent loss of a Peregrine falcon nest site at Lackagh Quarry
- A likely significant residual effect, at the local geographic scale, on all bat species due to the presence of the proposed road development within their foraging areas
- A likely significant residual effect, at the local geographic scale, for the permanent loss of 15 calcareous springs (FP1) at Lackagh Quarry, c.7.81ha of Dry-humid acid grassland (GS3) and c.0.13ha of Poor fen and flush habitat (PF2)

These significant residual impacts will also affect the following local biodiversity areas:

- Coast Road (R336) to the N59 Moycullen Road local biodiversity area

  Residual impact at the national geographic scale for the loss of Wet heath [4010] habitat

  Residual impact at the local geographic scale for the loss of Dry-humid acid grassland (GS3) and Poor fen and flush habitat (PF2) along with impacts on bat species present here

- River Corrib and the Coolagh Lakes local biodiversity area

  Residual impact at the local geographic scale due to impacts on bat species present here

- Menlough to Coolough Hill local biodiversity area

  Residual impact at the international geographic scale for the loss of Limestone pavement [*8240] habitat

  Residual impact at the county geographic scale for the loss of Petrifying springs [*7220] and impact on the Peregrine falcon

[108] As noted in **Table 8.40**, this comprises c.2.13ha of Wet heath dominated habitat and an additional c.0.87ha of habitat mosaic which contains Wet heath.

Residual impact at the local geographic scale from the loss of Calcareous springs (FP1) and along with impacts on bat species present here

- Ballindooley – Castlegar local biodiversity area

  Residual impact at the local geographic scale due to impacts on bat species present here

- Doughiska local biodiversity area

  Residual impact at the international geographic scale for the loss of Limestone pavement [*8240] habitat

  Residual impact at the local geographic scale due to impacts on bat species present here

Although the significant residual effects associated with the losses of Limestone pavement and Wet heath habitat cannot be directly compensated for, areas of related habitats will be created to provide an overall biodiversity gain for both peatland and limestone associated habitats locally. The area of Dry heath habitat being provided is c.7.06ha which is greater than the combined losses of all peatland habitats combined (c.4.78ha). The area of Calcareous grassland habitat being provided is c.7.14ha which is greater than the combined losses of Limestone pavement and Calcareous grassland habitat combined (c.1.24ha).

Table 8.41 presents an overall summary of the ecological receptors, their valuation and potential impacts. It presents the proposed mitigation measures for these potential impacts, the residual impacts, proposed compensation measures where applicable and the overall residual impact significance post-compensation.

Table 8.41: Summary of the Likely Significant Residual Effects of the Proposed Road Development on Biodiversity (post-compensation)

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance	Compensation	Residual Impact Significance Post-compensation
Designated Areas for Nature Conservation							
Lough Corrib cSAC (including Lough Corrib pNHA)	International (National)	**Construction** Habitat loss Habitat degradation – tunnelling/excavation Habitat degradation – hydrogeology Habitat degradation – hydrology Habitat degradation – air quality Habitat degradation – non-native invasive plant species Mortality risk **Operation** Habitat degradation – hydrogeology Habitat degradation – non-native invasive plant species Mortality risk	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect		
Galway Bay Complex cSAC (including Galway bay Complex pNHA)	International (National)	**Construction** Habitat degradation – hydrology Habitat degradation – non-native invasive plant species Barrier effect Mortality risk	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect		
Lough Corrib SPA (including Lough Corrib pNHA)	International (National)	**Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology Disturbance/displacement **Operation** Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect		
Inner Galway Bay SPA including Galway bay Complex pNHA)	International (National)	**Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology Disturbance/displacement **Operation** Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect		
Moycullen Bogs NHA	National	**Construction** Habitat degradation – air quality Habitat degradation – non-native invasive plant species Habitat degradation – hydrology **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale	Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5** Water quality during construction – **Section 8.6.4**	No likely significant residual effect		

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance	Compensation	Residual Impact Significance Post-compensation
Habitats (outside of designated areas for nature conservation)							
Limestone pavement [*8240]	International Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the international geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant residual effect at the international geographic scale	No	Likely significant residual effect at the international geographic scale
Petrifying springs [*7220]	International Importance	**Construction** Habitat loss	Likely significant effect at the county geographic scale (see **Section 8.5.4.3** under petrifying springs)	To reduce the scale of habitat loss – see **Section 8.6.2.1**	Likely significant residual effect at the county geographic scale (see **Section 8.7.2**)	No	Likely significant residual effect at the county geographic scale
Calcareous grassland [*6210/6210]	International/National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale (No *6210 affected – see **Section 8.5.4.3** under Calcareous grassland))	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant residual effect at the national geographic scale (see **Section 8.7.2**)	Yes, see **Section 8.9** and **Appendix A.8.26**	No likely significant residual effect
Dry heath [4030]	National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the national geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant residual effect at the national geographic scale (see **Section 8.7.2**)	Yes, see **Section 8.9** and **Appendix A.8.26**	No likely significant residual effect
Wet heath [4010][109]	National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – groundwater **Operation** Habitat degradation – groundwater	Likely significant effect at the national geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Groundwater during construction and operation – **Section 8.6.5**	Likely significant residual effect at the national geographic scale (see **Section 8.7.2**)	No	Likely significant residual effect at the national geographic scale
Molinia meadow [6410]	National Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation**	Likely significant effect at the national geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3**	Likely significant residual effect at the national geographic scale (see **Section 8.7.2**)	Yes, see **Section 8.9** and **Appendix A.8.26**	No likely significant residual effect

[109] Including areas of Wet heath/Dry heath/*Molinia* meadow [4010/4030/6410] mosaic

Ecological Receptor	**Ecological Valuation (after National Roads Authority, 2009)**	**Impacts with the Potential to result in Likely Significant Effects**	**Potential Impact Significance**	**Mitigation Measures**	**Residual Impact Significance**	**Compensation**	**Residual Impact Significance Post-compensation**
		Habitat degradation – non-native invasive plant species		Groundwater during construction and operation – **Section 8.6.5**			
Residual alluvial forest [*91E0]	International Importance	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the international geographic scale	Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant residual effect at the international geographic scale (see **Section 8.7.2**)	Yes, see **Section 8.9** and **Appendix A.8.26**	No likely significant residual effect
Turloughs [*3180]	International Importance	**Construction** Habitat loss Habitat degradation – surface water quality Habitat degradation – groundwater Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – groundwater Habitat degradation – non-native invasive plant species	Likely significant effect at the international geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Water quality during construction – **Section 8.6.4** Groundwater during construction and operation – **Section 8.6.5** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	No likely significant residual effect		
Hard water lakes [3140]	National Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the national geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect		
Mesotrophic lakes (FL4) *Part of Ballindooley complex*	County Importance[110]	**Construction** Habitat degradation – surface water quality	Likely significant effect at the county geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect		
Eutrophic lakes (FL5) *Part of Ballindooley complex*	County Importance[111]	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the county geographic scale	Water quality during construction – **Section 8.6.4** Groundwater during construction – **Section 8.6.5**	No likely significant residual effect		
Calcareous springs (FP1) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1**	Likely significant residual effect at the local geographic scale	No	Likely significant residual effect at the local geographic scale
Cladium fen [*7210]	International Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the international geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect		

[110] On the basis that it forms part of the wetland complex at Ballindooley Lough
[111] On the basis that it forms part of the wetland complex at Ballindooley Lough

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance	Compensation	Residual Impact Significance Post-compensation
Hydrophilous tall herb [6430]	International Importance	(see Lough Corrib cSAC above) **Construction** Habitat degradation – hydrogeology Habitat degradation – hydrology **Operation** Habitat degradation – hydrogeology	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect		
Alkaline fens [7230]	National Importance	**Construction** Habitat degradation – surface water quality (Ballindooley Lough)	Likely significant effect at the national geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect		
Reed and large sedge swamps (FS1) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality	Likely significant effect at the local geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect		
Tall-herb swamps (FS2) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect		
Eroding/upland rivers (FW1)	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality	Likely significant effect at the local geographic scale	Water quality during construction – **Section 8.6.4**	No likely significant residual effect		
Depositing/lowland rivers (FW2) River Corrib	International Importance	The River Corrib forms part of see Lough Corrib cSAC (see above and NIS)	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect		
Terryland River	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect		
Drainage ditches (FW4)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect		
Marsh (GM1)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect		
Dry calcareous and neutral grassland (GS1) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect		
Dry meadows and grassy verges (GS2) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect		
Dry-humid acid grassland (GS3) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant residual effect at the local geographic scale	No	Likely significant residual effect at the local geographic scale

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance	Compensation	Residual Impact Significance Post-compensation
Wet grassland (GS4) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect		
Rich fen and flush (PF1) Non-Annex I habitat type	County Importance	**Construction** Habitat degradation – surface water quality Habitat degradation – air quality	Likely significant effect at the county geographic scale	Water quality during construction – **Section 8.6.4** Air quality during construction - **Section 8.6.3**	No likely significant residual effect		
Poor fen and flush (PF2) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality **Operation** Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Air quality during construction - **Section 8.6.3**	Likely significant residual effect at the local geographic scale	No	Likely significant residual effect at the local geographic scale
(Mixed) broadleaved woodland (WD1)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant residual effect at the local geographic scale	Yes, see **Section 8.9**	No likely significant residual effect
Mixed broadleaved/conifer woodland (WD2)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect		
(Mixed) conifer woodland (WD3)	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect		
Hedgerows (WL1)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant effect at the local geographic scale	Yes, see **Section 8.9**	No likely significant residual effect
Treelines (WL2)	Local Importance (Higher Value)	**Construction** Habitat loss Habitat degradation – air quality Habitat degradation – non-native invasive plant species **Operation** Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	To reduce the scale of habitat loss – see **Section 8.6.2.1** Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	Likely significant effect at the local geographic scale	Yes, see **Section 8.9**	No likely significant residual effect

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance	Compensation	Residual Impact Significance Post-compensation
Oak-ash-hazel woodland (WN2) Non-Annex I habitat type	Local Importance (Higher Value)	**Construction** Habitat degradation – air quality Habitat degradation – non-native invasive plant species	Likely significant effect at the local geographic scale	Air quality during construction - **Section 8.6.3** Non-native invasive plant species during construction and operation – **Section 8.6.6** and **Appendix A.7.5**	No likely significant residual effect		
Scrub (WS1) Non-Annex I habitat type	Local Importance (Higher Value)	None	No likely significant effect at any geographic scale	None	No likely significant residual effect		
Fauna Species							
Badger	Local Importance (Higher Value)	**Construction** Loss of breeding/resting sites Disturbance/displacement **Operation** Habitat severance/barrier effect Mortality risk	Likely significant effect at the local geographic scale	Measures to protect Badger during construction – **Section 8.6.7.2.1** Measures to protect Badger during operation – **Section 8.6.7.2.2**	No likely significant residual effect		
Otter	International Importance	**Construction** Habitat degradation - water quality **Operation** Habitat severance/barrier effect Mortality risk	Likely significant effect at the local geographic scale	Measures to protect Otter during construction – **Section 8.6.7.1.1** Measures to protect Otter during operation – **Section 8.6.7.1.2**	No likely significant residual effect		
Other mammal species protected under the Wildlife Acts	Local Importance (Higher Value)	**Construction** Habitat degradation - water quality **Operation** Habitat severance/barrier effect Mortality risk	Likely significant effect at the local geographic scale	Measures to protect other mammal species (excl. bats) during construction – **Section 8.6.7.4.1** Measures to protect other mammal species (excl. bats) during operation – **Section 8.6.7.4.2**	No likely significant residual effect		
Lesser horseshoe bat	National Importance	**Construction** Roost loss Habitat loss Habitat fragmentation Disturbance/displacement **Operation** Mortality Barrier/severance effects Disturbance/displacement	Likely significant effect at the national geographic scale	Measures to protect bats during construction – **Section 8.6.7.2.1** Measures to protect bats during operation – **Section 8.6.7.2.2**	Likely significant effect at the national geographic scale	Yes, see **Section 8.9**	Likely significant residual effect at the local geographic scale
All other bat species	Local Importance (Higher Value)		Likely significant effect at the local geographic scale	Measures to protect bats during construction – **Section 8.6.7.2.1** Measures to protect bats during operation – **Section 8.6.7.2.2**	Likely significant effect at the local geographic scale	Yes, see **Section 8.9**	Likely significant residual effect at the local geographic scale
Marsh whorl snail	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality	Likely significant effect at the local geographic scale	Measures to protect the Marsh whorl snail during	No likely significant residual effect		

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance	Compensation	Residual Impact Significance Post-compensation
		Habitat degradation – groundwater **Operation** Habitat degradation – groundwater		construction – **Section 8.6.8.1.1** Measures to protect the Marsh whorl snail during operation – **Section 8.6.8.1.2**			
Marsh fritillary butterfly	County Importance	**Construction** Mortality risk	Likely significant effect at the local geographic scale	Measures to protect the Marsh fritillary butterfly during construction – **Section 8.6.8.2.1**	No likely significant residual effect		
SCI bird species	International	*see Lough Corrib SPA and Inner Galway Bay SPA above*	Likely significant effect at the international geographic scale	see Section 10 of the NIS	No likely significant residual effect		
Barn owl	County Importance	**Operation** Mortality risk	Likely significant effect at the county geographic scale	Measures to protect breeding birds during operation – **Section 8.6.9.1.2**	No likely significant residual effect		
Peregrine falcon	County Importance	**Construction** Loss of nest site Disturbance/displacement **Operation** Disturbance/displacement	Likely significant effect at the county geographic scale	Measures to protect breeding birds during construction – **Section 8.6.9.1.1** Measures to protect breeding birds during operation – **Section 8.6.9.1.2**	Likely significant residual effect at the county geographic scale	No	Likely significant residual effect at the county geographic scale
All other breeding bird species (non SCI)	Local Importance (Higher Value)	**Construction** Mortality risk Disturbance/displacement **Operation** Mortality risk Disturbance/displacement	Likely significant effect at the local geographic scale	Measures to protect breeding birds during construction – **Section 8.6.9.1.1** Measures to protect breeding birds during operation – **Section 8.6.9.1.2**	No likely significant residual effect		
All other wintering bird species (non-SCI)	Local Importance (Higher Value)	**Construction** Disturbance/displacement (Ballindooley Lough) Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Measures to protect wintering birds during construction – **Section 8.6.9.2.1** Measures to protect wintering birds during operation – **Section 8.6.9.2.2**	No likely significant residual effect		
Smooth newt Common frog	Local Importance (Higher Value)	**Construction** Habitat loss Disturbance & mortality risk Habitat degradation – surface water quality **Operation** Habitat severance/barrier effect	Likely significant effect at the local geographic scale	Measures to protect amphibians during construction – **Section 8.6.10.1** Measures to protect amphibians during operation – **Section 8.6.10.2**	No likely significant residual effect		
Common lizard	Local Importance (Higher Value)	**Construction** Habitat loss Disturbance & mortality risk **Operation**	Likely significant effect at the local geographic scale	Measures to protect reptiles during construction – **Section 8.6.11.1**	No likely significant residual effect		

Ecological Receptor	Ecological Valuation (after National Roads Authority, 2009)	Impacts with the Potential to result in Likely Significant Effects	Potential Impact Significance	Mitigation Measures	Residual Impact Significance	Compensation	Residual Impact Significance Post-compensation
		Habitat severance/barrier effect		Measures to protect reptiles during operation – **Section 8.6.11.2**			
Atlantic salmon European eel	International Importance	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Measures to protect fish species during construction – **Section 8.6.12.1**	No likely significant residual effect		
All other fish species recorded	Local Importance (Higher Value)	**Construction** Habitat degradation – surface water quality Habitat degradation – groundwater	Likely significant effect at the local geographic scale	Measures to protect fish species during construction – **Section 8.6.12.1**	No likely significant residual effect		
Local Biodiversity Areas							
Local biodiversity areas	The value of the biodiversity receptors recorded in the vicinity of the proposed road development, across the local biodiversity areas, range from Local Importance (Lower Value) to Internationally Important	Combinations of all of the potential impacts noted above The specific impacts are related to and dependent upon the potential impacts of the proposed road development on each of the individual ecological receptors that make up the biodiversity resource within a given local biodiversity area	Likely significant effects from local up to the international geographic scale	All of the mitigation measures included within **Section 8.6** The specific mitigation measures are related to and dependent upon the potential impacts of the proposed road development on each of the individual ecological receptors that make up the biodiversity resource within a given local biodiversity area	Likely significant effects from local up to the international geographic scale Refer to **Section 8.7.10** for breakdown by local biodiversity area	Yes, see **Section 8.9.1** for habitats and **Section 8.9.2** for bats	Yes, see **Section 8.10** for details

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9 Soils and Geology

9.1 Introduction

This chapter of the EIAR consists of an appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, under the heading of soils and geology.

This chapter sets out the methodology (**Section 9.2**), describes the receiving environment (**Section 9.3**) and summarises the main characteristics of the proposed road development which are of relevance for soils and geology (**Section 9.4**). The likely significant impacts of the proposed road development on soils and geology are described (**Section 9.5**). Measures are proposed to mitigate likely significant impacts (**Section 9.6**) and residual impacts are described (**Section 9.7)**. The chapter concludes with a summary (**Section 9.8**) and reference section (**Section 9.9**).

This chapter has utilised the information gathered during the previous phases of the proposed road development to inform the soils and geology impact appraisal. **Sections 4.4**, **6.5.2** and **7.6.2** of the **Route Selection Report** considered the soils and geology constraints within the scheme study area and compared the potential soils and geology impacts of the proposed route options respectively. These sections of the Route Selection Report contributed to the design of the proposed road development which this chapter appraises.

9.2 Methodology

9.2.1 Introduction

The following section outlines the legislation and guidelines considered and the adopted methodology for the preparing this chapter.

9.2.2 Guidelines

The main guidelines used in preparing this chapter are:

- Draft EPA Guidelines on the information to be contained in an EIS (EPA, 2015)
- Draft Advice Notes on preparing an EIS (EPA 2015)
- Transport Infrastructure Ireland (TII, the operational name of the National Roads Authority) guidelines on procedures for assessment and treatment of geology, hydrology and hydrogeology for National Road Schemes (TII, 2009), referred to as the TII Guidelines within this chapter
- EPA Guidelines on Information to be contained in EISs (EPA, 2002)
- EPA Advice Notes on current practice in preparation of an EIS (EPA, 2003)
- TII Environmental Impact Assessment of National Road Schemes – A Practical Guide (TII, 2008)

- Institute of Geologists of Ireland (IGI) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of EISs (IGI, 2013)
- Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA, 2017)

9.2.3 Study Area

The study area for the proposed road development extends 250m beyond the proposed development boundary. This is in accordance with the TII Guidelines. Where appropriate, the study area has been extended to include nearby geological features which may be impacted as a result of the construction and operation of the proposed road development. The study area is presented on the soils and geology suite of figures, **Figures 9.1.001** to **9.8.012**.

9.2.4 Baseline Data Collection

9.2.4.1 Introduction

In order to identify and quantify the potential impact of the construction and operation of the proposed road development, it is first necessary to undertake a detailed study of the existing (baseline) geological environment along the route of the proposed road development. This requires the collation and evaluation of available regional and local information and more site-specific data obtained from walkover surveys and both historic and commissioned ground investigations.

The information presented in this chapter is based on information obtained from two main data collections:

- Regional and local baseline desk study from:
  - Desk Study Information
  - Historic Ground Investigations
  - Consultations
- Project specific information from:
  - Ground Investigations
  - Field Surveys and Walkovers

9.2.4.2 Regional and local baseline desk study

Desk Study Information

The following sources of information were reviewed[1] in order to evaluate the soils and geological environment in the vicinity of the proposed road development:

- Current and historical Ordnance Survey maps available for the study area (1:2,500 and 1:10,560 scales), 2017

[1] The latest review of all available information sources was conducted in June 2017

- Aerial photography (2012 and 2016) of the study area, supplemented with a sectional drone survey in April 2016
- Aerial imagery from Google (imagery from 2001 to 2015) and Bing accessed in 2017
- Geological maps of the site area produced by the Geological Survey of Ireland (GSI) (www.dccae.gov.ie)
- MacDermot, C.V., McConnell, B. and Pracht, M. (2003) Geology of Galway Bay 1:100,000 scale Bedrock Geology Map Series, Sheet 14, Galway Bay, Geological Survey of Ireland
- Pracht, M., Lees, A., Leake, B., Feely, M., Long, B., Morris, J., McConnell, B. (2004) Geology of Galway Bay: A geological description to accompany the Bedrock Geology 1: 100,000 Scale Map Series, Sheet 14, Galway Bay. Geological Survey of Ireland
- Teagasc and the Environmental Protection Agency Irish Soil Information System (http://gis.teagasc.ie/soils/index.php)
- Flood, P. and Eising, J. (1987). The use of vertical band drains in the construction of the Galway Eastern Approach Road. Proceedings of the 9th European Conference on Soil Mechanics and Foundation Engineering, Dublin, Ireland
- Gannon, M.J. (year unknown) Corrib Quincentenary Bridge, Paper presented to Engineers Ireland
- Lidar elevation data commissioned by OPW
- Results from karst field surveys reported in the June 2016 karst report, Appendix A.9.2
- Constraints reports from the previous N6 Galway City Outer Bypass Scheme (2006 GCOB):
- Galway City Outer Bypass R336 Western Approach Constraints Study Report 2000
- N6 Galway City Outer Bypass Constraints Study Report (2000)
- N6 Galway City Outer Bypass R336 Western Approach Link Route Selection Report (2001)
- N6 Galway City Outer Bypass East Route Selection Report (2001)
- N6 Galway City Outer Bypass Environmental Impact Statement Volume 2 (2006)

Historic Ground Investigations

Ground investigation reports held by the Geological Survey of Ireland for the study area were sourced and details are as follows:

- R1340 Galway County Council Eastern Approach Road Galway (N6) (Ballybane – Doughiska), 1993

- R1365 Thos. Garland and Partners Digital Limited, Galway Industrial Estate, 1983
- R3176 Dermot Rooney and Associates I.D.A Business Park, Dangan, Galway, 1997
- R5906 Irish Linen Proposed Irish Linen Factory, Rahoon, Galway, 2005
- R6136 Galway County Council Residential Development, Headford Road, Galway, 2006
- R6898 Storm Technology Office Block Development, Dangan, Galway, 2006

In addition, ground investigation reports made available within the study area were also sourced and include the following:

- SSE Renewables Ireland, Galway Wind Park 110kV River Corrib Crossing, Menlough, Galway, 2013
- Galway County Council Galway City Outer Bypass Preliminary Ground Investigation, 2006

Consultations

Consultation was carried out with the relevant bodies as detailed below:

- Geological Survey of Ireland (GSI)
- Department of Housing, Planning and Local Government[2]
- Mineral Exploration & Mining Division of the Department of Communications, Climate Action and Environment3
- Teagasc
- Office of Public Works (OPW)
- Galway County Council
- Galway City Council
- Environmental Protection Agency (EPA)
- Landowners

Consultation with these relevant bodies, along with the other specialists on the project team, is ongoing since 2014.

9.2.4.3 Project-Specific Information

Site-specific data was obtained from the following sources:

- Historic Ground investigations (extracts from baseline data collection outlined in **Section 9.2.4.2**)
- Project Specific Ground investigations

[2] Please note that department names have changed during the development of this chapter and consultation may be addressed to a previous superseded name. The names which these departments are referred to currently are provided.

- Field Surveys and Walkovers

The scope of the ground investigations within the study area include:

- Shell and auger boreholes
- Rotary core boreholes
- Trial pits
- Window samples[3]
- Geophysical surveys
- Groundwater level monitoring
- Geotechnical and environmental testing on soil and groundwater samples

Commissioned Ground Investigations

Preliminary ground investigations (GI) were commissioned for the EIAR and details of these are as follows:

- N6 GCTP Phase II Ground Investigation Contract I, November 2015
- N6 GCTP Phase III Ground Investigation Contract I, April 2016
- N6 GCTP Phase III Ground Investigation Contract II, December 2015
- N6 GCTP Phase III Ground Investigation Contract III, December 2016

The ground investigation factual reports for each of these GI is include in **Appendix A.9.1**. A summary of the project specific ground investigation has also been provided in **Table 9.1**. The ground investigation locations are presented on **Figures 9.8.001** to **9.8.012**, **9.9.001** and **9.9.002**.

Table 9.1: Summary of Project Specific Ground Investigations

Project Specific Ground Investigation						
Ground Investigation Activity	**Unit**	**Phase 1 C1**	**Phase 2 C1**	**Phase 3 C1**	**Phase 3 C2**	**Phase 3 C3**
Cable Percussive Boreholes	no.	-	-	29	-	1
Rotary Holes	no.	2	4	40	5	3
Rotary Percussive Holes	no.	-	5	-	-	1
Trial Pits	no.	-	-	38	-	4
Soakaway Testing	no.	-	-	2	-	17
Window Samples	no.	-	-	4	-	
Multi Analysis Surface Wave	m	1726	-	-	-	

[3] A window sample is used to bore shallow boreholes, usually up to 5mbgl depending on the soil type, to obtain soil samples for assessment.

Project Specific Ground Investigation						
Ground Investigation Activity	**Unit**	**Phase 1 C1**	**Phase 2 C1**	**Phase 3 C1**	**Phase 3 C2**	**Phase 3 C3**
Seismic Refraction	m	1726	1285	8496	-	2175
2D Resistivity Survey	m	-	973	6027	-	2175
Electrical Resistivity Tomography	m	-	-	-	1897	
Microgravity	stations	-	-	-	118	

Walkover Surveys

Walkover surveys were conducted while scoping the ground investigation in September and October 2015 and throughout the duration of the ground investigation fieldwork which was conducted between January to May 2016 and December 2016. See also **Chapter 10, Hydrogeology** for a description of karst[4] field surveys.

9.2.4.4 Technical Limitations

The data included in the geological assessment includes existing data from earlier investigations into the region as well as dedicated field surveys and walk overs commissioned for the proposed road development. The data collected provides a comprehensive geological dataset along the route of the propose road development.

The data points provide valuable information on the soils and geology environment at point locations. Between each point the data is assessed by conservative interpretation. While soils and geology can vary the exploratory locations have been selected following the completion of the comprehensive baseline data collection. This review was completed by studying local geological maps, aerial photography, historic ground investigation and completing site walkovers to provide an understanding of the soils and geology. The location and the spacing of the exploratory locations was chosen in order to gain an understanding of the ground conditions. The ground investigation findings for the majority of cases compared favourably with the baseline data collection desk study. In instances where it did not, supplementary ground investigation was undertaken, these locations were:

- Peat areas, additional window samples were undertaken to the establish the peat extent
- Adjacent to the River Corrib, to establish the transition from granite to limestone and the extent of karst

[4] Karst refers to a distinctive terrain that evolves through dissolution of the bedrock and development of efficient underground drainage. The special landforms of karst include sinkholes, dry valleys, pavements, cave systems and associated springs (Waltham *et al.* 2005)

- Coolough, for Lackagh Tunnel to establish rockhead and extent of palaeokarst fill due to an unexpected buried valley feature which was encountered
- Briarhill, to investigate the water table due to unexpected groundwater conditions which were encountered (refer to **Chapter 10, Hydrogeology**)

Based on the comparability of the ground investigation and the baseline data collection the information is deemed sufficient to complete the soils and geology evaluation.

9.2.5 Impact Evaluation Methodology

Having defined the extent and form of the proposed road development, an evaluation is made of its potential likely significant impacts on the soils and geology environments. Mitigation measures are identified to mitigate any significant adverse impacts, where feasible.

This impact evaluation methodology is in accordance with the guidance outlined in Section 5.4 of the TII Guidelines (NRA, 2009) and in accordance with this guidance, all potential impacts of the proposed road development must be identified and assessed as per the conditions provided in **Table 9.2**.

Table 9.2: Identification of Impacts (Section 5.4.2 of TII Guidelines (NRA, 2009))

Condition	Classification	Description
Category of Impact	Direct Impact	Existing geological environment along or in close proximity to the proposed road development is altered, in whole or in part, as a consequence of road construction and/or operation
	Indirect Impact	Geological environment beyond the proposed road development is altered by activities related to road construction and/or operation
	No Predicted Impact	The proposed road development has neither a negative nor a positive impact on the geological environment
Effect of Impact	Positive	The proposed road development enhances a geological exposure
	Neutral	The proposed road development neither has a negative nor a positive impact on the geological environment
	Negative	The proposed road development results in a loss of a geological feature
Likelihood of Impact	Certain	Consideration should be given to such impacts in accordance with TII guidance (NRA, 2009)
	Likely	
	Possible	Consideration not required to such impacts in accordance with TII guidance (NRA, 2009)
	Unlikely	
Duration of Impact	Temporary	Construction related and lasting less than one year
	Short Term	Lasting one to 7 years
	Medium Term	Lasting between 7 to 15 years
	Long Term	Lasting 15 to 60 years

Condition	Classification	Description
	Permanent	Lasting over 60 years
Type / Nature of Impact	**Cumulative**	Combination of many minor impacts create one, larger, more significant impact
	Potential	Impact of the proposed development before mitigation measures are fully established
	Worst – Case	Impact of the proposed development should mitigation measures substantially fail to fulfil their intended function
	Residual	Final or designed impact which results after proposed mitigation measures have been fully established

In accordance with Section 5.4.3 of the TII Guidelines, the rating criteria for assessing the importance of geological features within the study area are outlined in **Table 9.4** and the rating criterion for quantifying the magnitude of impacts is outlined in **Table 9.5**. The rating of potential environmental impacts on the soils and geology environment are based on the matrix presented in **Table 9.6** below which takes account of both the importance of an attribute and the magnitude of the potential environmental impacts of the proposed road development on it.

The magnitude of impacts should be defined in accordance with the criteria provided in the EPA Guidelines. This is outlined in **Table 9.3**.

Table 9.3: Definition of Magnitude of Impact (Table 5.1 (NRA, 2009))

Magnitude of Impact	Description
Imperceptible	An impact capable of measurement but without noticeable consequences
Slight	An impact that alters the character of the environment without affecting its sensitivities
Moderate	An impact that alters the character of the environment in a manner that is consistence with existing or emerging trends
Significant	An impact which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment
Profound	An impact which obliterates all previous sensitive characteristics

These impact ratings are in accordance with impact assessment criteria provided in the aforementioned EPA Guidelines. The criteria apply to potential impacts during both the construction and operational phases.

Table 9.4: Criteria for rating the importance of identified geological features (Table C2 (IGI, 2013) and Box 4.1 (NRA, 2009))

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and / or soft organic soil underlying route is significant on a national or regional scale.	Geological feature rare on a regional or national scale (NHA) Large existing quarry or pit Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and / or soft organic soil underlying route is significant on a local scale.	Contaminated soil on site with previous heavy industrial usage Large recent landfill site for mixed wastes Geological feature of high value on a local scale (County Geological Site) Well drained and / or highly fertility soils
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and / or soft organic soil underlying route is moderate on a local scale.	Contaminated soil on site with previous light industrial usage Small recent landfill site for mixed wastes Moderately drained and / or moderate fertility soils Small existing quarry or pit
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and / or soft organic soil underlying route is small on a local scale*.	Large historical and / or recent site for construction and demolition wastes Small historical and / or recent landfill site for construction and demolition wastes Poorly drained and / or low fertility soils. Uneconomically extractable mineral resource

Note: * relative to the total volume of inert soil disposed of and/or recovered

Table 9.5: Criteria for Rating Soil and Geology Impact Significance and Magnitude at EIS Stage (Table C4 (IGI, 2013) and Box 5.1 (NRA, 2009))

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute	Loss of high proportion of future quarry or pit reserves Irreversible loss of high proportion of local high fertility soils Removal of entirety of geological heritage feature Requirement to excavate / remediate entire waste site Requirement to excavate and replace high proportion of peat, organic soils and / or soft mineral soils beneath alignment
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Loss of moderate proportion of future quarry or pit reserves Removal of part of geological heritage feature Irreversible loss of moderate proportion of local high fertility soils Requirement to excavate / remediate significant proportion of waste site Requirement to excavate and replace moderate proportion of peat, organic soils and / or soft mineral soils beneath alignment
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Loss of small proportion of future quarry or pit reserves Removal of small part of geological heritage feature Irreversible loss of small proportion of local high fertility soils and / or high proportion of local low fertility soils Requirement to excavate / remediate small proportion of waste site Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	No measurable changes in attributes
Minor Beneficial	Results in minor improvement of attribute quality	Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate enhancement of geological heritage feature
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

Table 9.6: Rating of Significant Environmental Impacts at EIS Stage (Table C6 (IGI, 2013) and Box 5.4 (NRA, 2009))

		Magnitude of Impact			
		Negligible	Small	Moderate	Large
Importance of Attribute	**Extremely High**	Imperceptible	Significant	Profound	Profound
	Very High	Imperceptible	Significant / Moderate	Profound / Significant	Profound
	High	Imperceptible	Moderate / Slight	Significant / Moderate	Severe / Significant
	Medium	Imperceptible	Slight	Moderate	Significant
	Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

The appraisal of the potential likely significant impacts of the proposed road development on soils and geology will consider the following specific topics in accordance with the TII Guidelines (TII, 2009):

- Soils (range of agricultural uses, fertility and drainage characteristics)
- Requirements for treatment and/or handling of soft, unstable or contaminated soils, subsoils or other geological materials
- Requirements for excavation, disposal and / or recovery of soils, subsoils or other geological materials which may be unsuitable for re-use in construction of earth structures or present a risk to human health and/or the environment
- Environmental impact of engineering works on, in or over karst features (buried open / infilled cavities, slope and pavement stability)
- Impact on Economic Geology (mines, pits and quarries) either currently being extracted or potentially developable in the future
- Geological Heritage
- Requirements for blasting in cuttings which may impact on existing structures or infrastructure nearby (noise and vibration)
- Requirements for transportation and truck movements of excavated material and disposal of waste material (traffic, noise and vibration)
- Requirements for pile driving at bridge structures which may impact on existing structures or infrastructure nearby (noise and vibration)
- Requirements for tunnel construction which may impact on existing structures or infrastructure nearby (noise and vibration, settlement and instability)

An analysis of the potential impacts of the proposed road development on soils and geology during construction and operation is presented in **Section 9.5**.

Through the evolution of the design of the proposed road development measures were included in the design to reduce or avoid specific impacts where possible.

Following the evaluation of potential impacts as a result of the design, specific mitigation measures have been developed to avoid, prevent, reduce and, if possible, remedy any significant adverse impacts on the soils and geology. These are described in **Section 9.6** below. Residual impacts which are the final impacts which result after mitigation measures have been fully established are described in **Section 9.7 Table 9.19** and **Table 9.20**.

9.3 Receiving Environment

9.3.1 Introduction

This section describes the soils and geology within the study area. A regional overview is provided in terms of the geomorphology, topography, soils and solid geology of the local area followed by sub sections identifying the feature importance ranking of the agricultural soils, superficial deposits, bedrock geology, soft and unstable ground, contaminated land, karst solution features, mineral and aggregate resources and geological heritage sites within the study area.

When examining the receiving environment of the study area, the proposed road development has been divided into four sections for ease of presentation and due to the volume of information available. For consistency, these sub-divisions are also applied in **Chapter 10, Hydrogeology**. The four sections are as follows:

- Section 1: Chainage 0+000 to 8+500 (R336 to the N59 Moycullen Road)
- Section 2: Chainage 8+500 to 9+400 (N59 Moycullen Road to the River Corrib)
- Section 3: Chainage 9+400 to 14+000 (River Corrib to the N83 Tuam Road)
- Section 4: Chainage 14+000 to 17+500 (N83 Tuam Road to the existing N6 at Coolagh)

These four sections of the proposed road development are discussed in **Sections 9.3.2** to **9.3.12**.

The description of the regional overview is sub-divided and discussed in terms of the western and eastern areas, which are separated by the River Corrib. Section 1 and 2 of the study area covers the western area and the eastern area covers Sections 3 and 4.

The receiving environment is presented on **Figures 9.1.001** to **9.8.012**.

In **Section 9.2.18** a conceptual site model is presented on **Figures 9.8.001** to **9.8.0012** and summarised in **Table 9.16**. The conceptual model plots the factual ground investigation data within the study area along the existing ground level against the proposed road level, earthworks areas and chainage of the proposed road development. **Table 9.16** presents additional information for each earthworks area.

9.3.2 Regional Overview

The proposed road development traverses from west to east of Galway on the northern side of Galway City. This section will discuss the following aspects of the region surrounding the proposed road development:

- Regional Geomorphology and Topography
- Regional Soils and Bedrock Geology

9.3.2.1 Regional Geomorphology and Topography

The general geomorphology of the western area consists of gently undulating to hummocky[5] topography in areas overlying granite. The ground level is lowest at the shores of Lough Corrib and along the coast (10m OD) and rises to the high points at Gortacleva / Tonabrocky (111m OD), Derry Crih (96m OD) and Corcullen (90m OD). The GSI maps indicate ridge lines exist at Tonabrocky and Derry Crih which run northwest-southeast.

The proposed road development crosses the River Corrib near Menlo Castle on the eastern bank and on the western side it passes through National University of Ireland Galway (NUIG) Sporting Campus at Dangan. On crossing the River Corrib, the topography to the eastern area is less undulating than in the western area. The area around the River Corrib is relatively flat and rises to the east. The highest point is at Coolough (65m OD). This is also directly beside the disused Lackagh Quarry in Coolough. From this point the ground surface gently slopes towards Ballindooley Lough and rises again towards Twomileditch (60m OD). The Geological Survey of Ireland (GSI) have produced Quaternary Geology [6] mapping for Ireland. A presentation of the mapping is provided in **Figures 9.1.001** to **9.1.002** and **Figure 9.1.101** to **9.1.114**.

The Galway Granite Batholith is recorded as an indicator erratic or a known source area, with path direction or known erratic train to the south of Ireland. Glacial erracatics are evident east of the River Corrib.

Striation[7] is rather non-uniform to the west of the River Corrib. However the majority of striae direction and drumlins face in a north to northeast direction. The striae direction, streamlined bedrock and drumlin direction in the east of the River Corrib is provided as a northeast direction.

The Lower Carboniferous Visean Limestone is known to contain karst solution feature including surface features such as springs, turloughs and swallow holes which are present east of the River Corrib. Limestone pavement is also common throughout the study area, east of River Corrib and is located both outside and

[5] Hummocky terrain is defined as uneven or undulating surface which contains subdued and rolling landforms.

[6] The Quaternary mapping consists of unconsolidated sediments, the distribution and outline of the main geomorphological features and ice direction indicators.

[7] This refers to glacial striation or scratches, gouges cut into bedrock by glacial abrasion during movement of the glacier.

within the Lough Corrib cSAC, refer to **Chapter 8, Biodiversity** for the ecological assessment of Limestone pavement.

The proposed road development intercepts several watercourses, predominately to the west of the River Corrib. To the east of the River Corrib, due to the highly karstic nature of the terrain, there is a very sparse network of watercourse features. Lake features include Coolagh Lakes and Ballindooley Lough which are located east of the River Corrib. For further details refer to **Chapter 11, Hydrology**. Blanket peat is widespread on the west of the River Corrib but reduces toward the river. Some isolated areas of cutover peat also exist on the eastern side of the River Corrib.

9.3.2.2 Regional Soils and Bedrock Geology

Generally the western area consists of a mix of peaty podzols, blanket peat, lithosols / regosols and surface water gleys, overlying predominantly granular glacial till over early-middle Devonian granite intrusions known as the Galway Granite Batholith and other igneous intrusive rocks. The lowest ground level is at the shores of Lough Corrib where alluvial deposits and fen peat are encountered. The land in the western area is predominantly used as agricultural land with the lands closer to the River Corrib becoming more urban with many residential, commercial and University areas.

The soils in the east consists predominantly of grey brown podzolics, lithosols peat and renzinas / lithosols, overlying cohesive glacial till derived from the underlying bedrock consisting of overly karstified Carboniferous Visean Limestone. Pracht 2013 refer to these limestone as the Burren Formation. Palaeolandscape features (and likely palaeokarst) were identified which comprise of features of significantly deep infilled buried valleys. The land in the eastern area is predominantly used as agricultural land with the area between Ballybrit and Briarhill as an urban environment. Within this area there is an active and disused limestone quarry located in Twomileditch and Coolough, Menlough respectively.

9.3.3 Agricultural Soils

Soil within the study area was assessed based on agricultural usage, fertility and drainage characteristics. Teagasc developed a national indicative soil map, which classifies the soils of Ireland into simplified categories. The Teagasc Soil Mapping has been reproduced in **Figure 9.2.001** to **Figure 9.2.002** and **Figure 9.2.101** to **9.2.114**. Cognisance was taken of the CORINE (Co-Ordinated Information on the Environment) dataseries, established by the European Community (EC) and nationally coordinated by the EPA, when interpreting the Teagasc Soil maps. This section looks at the agriculture soil only. Potential agriculture impacts are assessed in **Chapter 14, Material Assets Agriculture**.

A summary of the agricultural soils present along the proposed road development and their associated feature importance is provided in **Table 9.7**.

Section 1: Chainage 0+000 to 8+500

The soil from Na Foraí Maola to Aille is typically described as poorly drained shallow deposits with peaty topsoil. From Aille to Dangan, the soil description changes to become a shallow to deep, well drained, non-calcareous deposit. These areas are typically described as agricultural lands with arable land and pastures. Some vegetation typical of peatlands exists in both An Chloch Scoilte and Aille.

Section 2: Chainage 8+500 to 9+400

Soil in the central part of the study area, in the vicinity of the River Corrib, is primarily described as made ground with alluvial deposits indicated along the river catchment. This area has no agricultural soil value as it is part of the urban fabric.

Section 3: Chainage 9+400 to 14+000 and Section 4: Chainage 14+000 to 17+500

To the east of the River Corrib, the majority of the land is described as well drained, with a high percentage of agricultural, fertile land, mixed with small clusters of residential and industrial facilities.

Land is predominantly natural however the potential for contaminated ground is further discussed in **Section 9.3.8**.

Table 9.7: Geological Feature Importance of Soil within Study Area

Soil Type	Description	Location / General Extent	Feature Importance Ranking
Teagasc Soils			
AminSRPT	Shallow, lithosolic or podzolic type soils potentially with peaty topsoil. Predominantly shallow soils derived from non-calcareous (granite) rock or gravels with / without peaty surface horizon	Generally from Na Foraí Maola to An Chloch Scoilte	Low
BktPt	Blanket Peat	An Chloch Scoilte	Low
AminSW	Shallow well drained mineral. Derived from mainly non-calcareous (granite) parent materials	Generally from An Chloch Scoilte to Ballard	High
AminDW	Deep well drained mineral soils derived from mainly non-calcareous (granite) parent materials	Aille to Cappagh and Ballyburke to Dangan	High
AminPD	Deep poorly drained mineral derived from mainly non-calcareous (granite) parent materials	Various locations along the western section of the study area	Low
Made	Made Ground	Dangan to Menlough and Ballybrit	Low
AlluvMIN	Mineral Alluvium	Menlough	Low

Soil Type	Description	Location / General Extent	Feature Importance Ranking
BminSW	Shallow well drained mineral. Derived from mainly calcareous (limestone) parent materials	Generally from Menlough to Ballindooley	High
BminSRPT	Shallow, lithosolic or podzolic type soils potentially with peaty topsoil. Predominantly shallow soils derived from calcareous (limestone) rock or gravels with / without peaty surface horizon	Lackagh and Ballybrit	Low
Cut	Cutover Peat	River Corrib and Ballindooley Lough	Low
BminDW	Deep well drained mineral. Derived from mainly calcareous (limestone) parent minerals	Generally from Ballindooley to Coolagh	High
BminPD	Deep poorly drained mineral. Derived from mainly calcareous parent minerals	Various locations along the eastern section of the study area	Low
BminPDPT	Poorly drained mineral soils with peaty topsoil. Derived from mainly calcareous (limestone) parent materials	Various locations along the eastern section of the study area	Low

9.3.4 Superficial Deposits

Superficial deposits refer to geological deposits associated with the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 2.6 million years from the present (http://www.bgs.ac.uk/products/digitalmaps/digmapgb_drift.html).

The Irish Soil Information System [8]project has developed a national association soil map for Ireland, providing information on soil types and properties across Ireland.

Superficial deposits were established based on the Irish National Soil Map 1:250,000, the Teagasc Subsoil Map and relevant ground investigation information along the proposed road development.

A reproduction of the Irish National Soil map 1:250,000, as provided by Teagasc and Cranfield University, has been provided in **Figure 9.3.001** to **Figure 9.3.002** and **Figure 9.3.101** to **Figure 9.3.114**. The Teagasc Subsoil Map, produced by Teagasc, EPA and GSI, was also consulted. This map has also been reproduced in **Figure 9.4.001** to **Figure 9.4.002** and **Figure 9.4.101** to **Figure 9.4.114**.

[8] The Irish Soil Information System project has developed a national association soil map for Ireland at a scale of 1:250,000. The project is co-funded by Teagasc and the Environmental Protection Agency (EPA) Science, Technology and Research & Innovation for the Environment (STRIVE) programme (http://gis.teagasc.ie/isis/about.php)

A summary of the superficial deposits are presented in **Table 9.8**.

Section 1: Chainage 0+000 to 8+500

Generally Section 1 consists of peat over a mixture of granular glacial deposits and highly weathered granite.

Section 2: Chainage 8+500 to 9+400

Section 2 is comprised of shallow granular granite derived till over weathered granite, with some instances of peat. This changes to soft to firm sandy gravelly clay over weathered limestone at the intersection of the rock types.

Section 3: Chainage 9+400 to 14+000 and Section 4: Chainage 14+000 to 17+500

East of the River Corrib, the study area typically consists of glacial till derived from limestone, over weathered limestone. Instances of palaeolandscape infilling were uncovered in various low-lying areas within the study area in Menlough, Coolough, Castlegar and Terryland.

Areas of soft and / or unstable ground are discussed further in **Section 9.3.7**.

Table 9.8: Geological Feature Importance of Superficial Deposits within Study Area

Strata[9]	**General Extent / Location**	**Depth to Top of Strata (m BGL)**	**Thickness Range (m)**	**Notes / Description**
Topsoil	Widespread	0.0	0.0 – 0.7	Occasionally peaty in nature
Made Ground	Widespread	0.0 – 0.3	0.0 – 1.9	Occasional fragments of concrete, red brick, ceramic pipe, timber
Peat	Section 1 and 3	0.0 – 0.8	0.0 – 1.3	Occasionally slightly sandy
Glacial Till derived from Granite	Section 1	0.1 – 2.3	0.0 – 3.5	Cohesive and granular mix
Glacial Till derived from Limestone	Section 2 to 4	0.1 – 1.9	0.0 – 21.6	Cohesive and granular mix
Palaeolandscape Fill	Section 2 and 3	13.7 – 101.5	87m (only confirmed thickness)	Described as silt, organic clay, and a transition zone consisting of cobbles and boulders

[9] Strata indicated may not be present at all locations along the proposed road development.

9.3.5 Bedrock Geology

The underlying bedrock geology was determined based on the Bedrock Geology 1:100,000 online mapping (Geological Survey of Ireland), and relevant ground investigation along the route of the proposed road development and is presented in **Figures 9.5.001** to **Figure 9.5.002** and **Figure 9.5.104** to **Figure 9.5.114**.

Section 1: Chainage 0+000 to 8+500

Section 1 is underlain by the Galway Granite Batholith which consists of a number of distinct granite intrusions and is faulted into three main parts by the Shannawona north northeast trending faults and the Bearna northwest trending faults. The Bearna Fault is indicated by the GSI as running approximately through the center of Section 1 at Aille / Ballard. Faulting in the Galway Granite Batholith was not confirmed in intrusive investigation.

To the west of the inferred Bearna Fault, the underlying granite is described as a black, grey, pink, biotite Megacrystic-Porphyritic Granite. The coarse grained, pink, phenocrystic K-feldspar granite known as the Errisbeg Townland Granite occurs to the east of the fault.

Late stage felsite, quartz porphyry and granite porphyry dykes cross almost all of these intrusions.

The white to grey fine grained aphyric felsic Murvey Granite occurs at or near the margins of the batholith and also at the eastern end of Section 1 in Dangan. The Murvey Granite is considered to be the most fractionated of all the granites in the batholith.

Section 2: Chainage 8+500 to 9+400

West of the River Corrib, the study area is typically underlain by Early to Middle Devonian granite intrusions within the Galway Granite Batholith. The Murvey Granite occurs at the outer periphery of the Errisbeg Townland Granite, adjacent to the Lower Carboniferous Visean Limestone known as the Burren Formation.

The area of limestone between the western shore of the River Corrib and the fault bounding the pre-Carboniferous rocks to the west were originally mapped by C.V. MacDermot in the late 1960's and early 1970's. Based on the results of the project specific ground investigation, the rock type change occurs in the vicinity of the unconformity line. Intrusive investigation and geophysical investigation confirmed the high likelihood that the change in rock type occurs at Ch. 8+880. On the limestone side of the indicative chainage, a zone of low resistivity that is up to 40m wide and greater than 20m deep was encountered. This is likely to be a highly weathered zone at the contact zone. East of this zone, the geology sharply reverts to high resistivity, typical of competent limestone. Therefore, this unconformity line / fault is still considered valid and provided in **Figures 9.5.001** to **Figure 9.5.002** and **Figure 9.5.104** to **Figure 9.5.114**.

The rock is described as thick to thinly bedded, however, the majority of intrusive coring indicates that the limestone rockmass is thinly bedded. Average depth to rock is approximately 5.0m below ground level, however intrusive investigation along the River Corrib indicates that rock can drop to 78m below ground level.

Section 3 and 4: Chainage 9+400 to 17+500

The area to the east of the River Corrib is underlain by the Burren Formation (Visean) of the Lower Carboniferous age. There is limited available information on the depositional sequencing of the Burren Formation west and east of Lough Corrib. The exploratory descriptions for the limestones encountered during the site investigation vary widely and therefore no trend or isolated areas of distinct characteristics have been observed. The bedrock topography associated with the palaeolandscape was encountered at depths deeper than elsewhere within the study area.

Some argillaceous (clayey) material was recorded in the coreholes. The nature of the limestone strongly influences its susceptibility to karstification. Purer limestones (>90% calcite) are more susceptible than impure (shaley / argillaceous) limestones.

The average depth to rock across the Sections 3 and 4 (excluding areas of palaeolandscape features) is approximately 2.4m below ground level. Intrusive coring indicates that the rock is massive to thinly bedded.

Karst within the limestone is discussed in **Section 9.3.6**.

A summary of the bedrock formations and associated descriptions is provided in **Table 9.9**.

Table 9.9: Rock Formations within Study Area

Geological Period	**Bedrock Unit**	**Formation**	**Description**	**General Extent / Location**
Carboniferous	Dinantian Pure Bedded Limestone	Burren Formation (Visean)	Medium to very strong massive to thinly bedded blueish dark grey fine grained slightly weathered	**Section 2, 3** and **4** East of River Corrib, with small section west of river bank
Early-Middle Devonian	Galway Granite Batholith	Porphyritic-Megacrystic Granite	Very strong grey, white, pink, black biotite slightly weathered	**Section 1** Coast Road (R336) to Aille *Principal granite mass west of the Bearna Fault*
		Fine Grained Foliated Granite	Very strong thickly to thinly banded brown pink green medium to coarse grained slightly weathered	**Section 1** Between An Chloch Scoilte and Ballard
		Errisbeg Townland Granite	Very strong thickly to thinly banded brownish purple	**Section 1** and **2** Aille to Dangan

Geological Period	Bedrock Unit	Formation	Description	General Extent / Location
			fine to coarse grained slightly weathered	*Principal granite mass east of Bearna Fault*
		Murvey Granite	Very strong thickly to thinly banded green, white fine coarse grained moderately weathered	**Section 1** and **2** Dangan *Border formation between principal granite and visean limestone*
Ordovician	Other Igneous Intrusive Rocks	Metagrabbo and Orthogneiss Suite (undifferentiated)		**Section 1** and **2** Dangan

9.3.6 Karst Solution Features

From the N59 Moycullen Road at Dangan (Section 1) to the existing N6 at Coolagh, Briarhill (Section 4) the study area is underlain by clean non-argillaceous limestone which is prone to karst. A range of solution features were identified within the study area and presented in **Figure 9.6.001** to **Figure 9.6.002**, **Figure 9.6.101** to **Figure 9.6.114**, **Figure 10.1.001** to **Figure 10.1.002** and **Figure 10.1.101** to **Figure 10.1.114**. These include:

- Limestone pavement
- Epikarst
- Dolines (enclosed depressions)
- Caves
- Estavelles
- Springs
- Superficial Solution Features
- Wells
- Swallow holes
- Turloughs

The solution features have been identified based on the GSI Karst Database and were further assessed in a project specific karst survey, which is available in **Appendix A.9.2**.

Section 1: Chainage 0+000 to 8+500

There is no karst in Section 1 as this area is underlain by granite which is not susceptible to karst.

Section 2, 3 and 4: Chainage 8+500 to 17+500

The Teagasc subsoil mapping indicates that approximately 40% of the landcover over the limestone bedrock is karstified outcrop or subcrop. Site walkovers and ground investigation established that much of Section 3 and 4 is limestone subcrop with a thin / shallow layer of topsoil, glacial till.

Areas of Limestone pavement were uncovered and mapped in Sections 3 and 4. Limestone pavement, which is underlain by limestone bedrock accounts for approximately 10% of the land cover. Limestone pavement occurs within and outside European designated sites. For the purpose of the geological assessment no differentiation has been made between Limestone pavement located within or outside the European designated sites. Refer to **Chapter 8, Biodiversity** for an ecological assessment of Limestone pavement.

Most of the karstification identified along the proposed road development consists of a weak to well-developed zone of epikarst[10], ranging from approximately 0m to 2.7m in thickness[11] (epikarst refers to the zone of partially weathered or weathered limestone which is present between the overburden soils and the underlying unweathered rock).

In a smaller number of areas, more intense karstification has led to deeper weathering (below the epikarst zone) and clay infilling of solutionally enlarged features (typically joints). In some of these, even more intense karstification has occurred, leading to the development of relatively large dissolution features which are typically infilled with sediments. The establishment of the location of these features is achieved through geophysical surveys and intrusive investigation.

Palaeokarst features have been identified with the bedrock formation. These consist of large buried valleys filled with silt and clay.

Various anomalies were encountered in both intrusive investigation and geophysical surveys, which may likely be karst related. These include the following:

- Non intact zones identified in rotary coreholes below bedrock level
- Cavities in rotary coreholes
- Calcite deposits and infilled voids identified in rotary coreholes
- Significant drop in resistivity values recorded during the geophysical survey which do not coincide with typical bedrock resistivity values

[10] Epikarst comprises of highly weathered carbonate bedrock immediately beneath the surface or soil where present.

[11] The values provided are representative of the typical thicknesses observed / recorded. Weathered rock was recorded as 6.4m thick in BH 3/35R conducted during the N6 GCTP Phase 3 Contract 1 Ground Investigation in 2016. However, based on site observations during monitoring of the works and available geophysical data, the material was a mixture of cobbles and boulders with dense granular content. This was an isolated record.

Such anomalies were encountered at various locations across the study area underlain by limestone bedrock. The location of these anomalies are presented in the ground investigation factual data and are not included in

Table 9.10. Refer to **Chapter 10, Hydrogeology** for a full description of both surface karst features and anomalies recorded from the ground investigations.

Table 9.10: Geological Feature Importance of Karst Features within Study Area

ID Code	Karst Feature	Information Source	Location / General Extent	Feature Importance Ranking
Limestone Pavement				
LP	Limestone pavement	Field mapping from Ecologist	Widespread throughout Sections 3 and 4	Very High[12]
Palaeolandscape (Palaeokarst)				
PK	Palaeokarst Valley	Mapping from Hydrogeologist	Menlough, Ballindooley Castlegar	Medium
Surface Karst Solution Features				
K7	Spring	Field Survey	Bushypark	Medium
K10	Enclosed Depression	Field Survey	Bushypark	Medium
K11	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Bushypark	Medium
K12	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Bushypark	Medium
K17	Spring	Field Survey	Menlough	Medium
K25	Spring	Lidar, Bing Maps, Google Maps, Aerial Photography, OSI Water Line	Menlough	Medium
K31	Turlough	Scott Cawley Ecologists Surveys	Menlough	Medium
K44	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Coolagh	Medium
K45	Spring	Lidar, Bing Maps, Google Maps, Aerial Photography, OSI Water Line	Coolagh	Medium
K49	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Coolagh	Medium

[12] Limestone pavement is ranked based on its soils and geological feature importance not as ecological importance. Refer to **Chapter 8, Biodiversity** for ecological importance rating.

ID Code	Karst Feature	Information Source	Location / General Extent	Feature Importance Ranking
K51	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Coolagh	Medium
K54	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Coolagh	Medium
K57	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Coolagh	Medium
K59	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Coolagh	Medium
K61	Enclosed Depression	Field Survey	Coolagh	Medium
K62	Enclosed Depression	Field Survey	Coolagh	Medium
K64	Enclosed Depression	Field Survey	Coolagh	Medium
K67	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Coolagh	Medium
K70	Enclosed Depression	Field Survey	Coolagh	Medium
K71	Enclosed Depression	Field Survey	Coolagh	Medium
K97	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Castlegar	Medium
K104	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Castlegar	Medium
K131	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Parkmore	Medium
K158	Spring	OSI Water Line map	Coolagh	Medium
K161	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972	Coolagh	Medium
K166	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972	Coolagh	Medium
K172	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Coolagh	Medium

ID Code	Karst Feature	Information Source	Location / General Extent	Feature Importance Ranking
K175	Enclosed Depression	Field Survey	Coolagh	Medium
K176	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972	Coolagh	Medium
K178	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972	Coolagh	Medium
K179	Enclosed Depression	Field Survey	Coolagh	Medium
K180	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972	Coolagh	Medium
K181	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972	Coolagh	Medium
K193	Enclosed Depression	Field Survey	Coolagh	Medium
K328	Enclosed Depression	Bing Maps	Parkmore	Medium

9.3.7 Soft and/or Unstable Ground

Soft deposits consist of peat, alluvium or very soft cohesive material. These soft compressible deposits, which are located within the study area, are presented in **Figure 9.7.001** to **Figure 9.7.002** and **Figure 9.7.101** to **Figure 9.7.114**. Various sources of information were consulted in establishing these areas along the study area namely:

- Teagasc Subsoil map, produced by Teagasc, EPA and GSI
- GSI database of historical landslides
- EPA subsoil mapping
- Ground Investigation data

The Teagasc Subsoil map outlined locations of soft soil within the study area and the GSI database shows no recorded landslide events within the study area.

Areas containing peat and very soft to soft cohesive material identified within the study area were primarily obtained through assessment of intrusive investigation and consultation of the EPA Subsoil mapping. The ground investigation soil log descriptions (soft, very soft) and in-situ strength testing were used to determine the location of soft deposits. In accordance with EN ISO 14688-2:2004, material with an undrained shear strength of 40 kPa is considered a soft deposit.

According to the Teagasc subsoil mapping for the county, less than 1% of the peatland areas in County Galway fall within the study area. Areas containing peat and soft soil are displayed in **Figure 9.7.001** to **Figure 9.7.002** and **Figure 9.7.101** to **Figure 9.7.114** and the conceptual site model as presented in **Figure 9.8.001** to **Figure 9.8.012**.

Section 1: Chainage 0+000 to 8+500

Intrusive investigation indicates the existence of peaty topsoil and shallow deposits of peat throughout Section 1. The evidence and likelihood of this material reduces at Dangan, where the landcover enters the urban fabric. Typically, the depths observed for the peat were less than 1.0m however a number of locations were identified where the peat extended up to thicknesses of 2.0m or soft deposits up to thicknesses of 3.6m, as presented in **Figure 9.8.001** to **Figure 9.8.012**. The soft deposits are typically non-organic, however organic deposits were encountered in Na Foraí Maola and Aille. These are isolated instances only and are likely due to the overlying peat.

Section 2: Chainage 8+500 to 9+400

Peat is recorded in the upper, northern part of the study area within Section 2. Alluvial deposits and highly organic soft deposits were encountered along the bank of the River Corrib.

Section 3: Chainage 9+400 to 14+000

Peat was observed in the valley area at Coolough, Menlough, west of Lackagh Quarry. This is mixed with highly organic soft ground deposits and alluvial deposits as per the intrusive investigation and GSI subsoil mapping. Geophysical surveying during the commissioned site investigation indicates that the likely deposition of these deposits as is associated with infilling of deep buried valleys or palaeovalleys.

A significant palaeokarst feature was uncovered west of Lackagh quarry with palaeokarst fill encountered to 101.5m below ground level (blg) in one exploratory hole. This is significantly deeper than the shallow bedrock in the immediate vicinity which includes Limestone pavement.

Peat was also encountered at Ballindooley Lough, with historic ground investigation showing peat up to 3.7m in thickness. Soft deposits, mixed with peat are expected both west and east of the N84 Headford Road, as the geophysical survey indicate the potential presence of deep buried valleys either side of the N84 Headford Road.

Section 4: Chainage 14+000 to 17+500

Isolated instances of soft ground were encountered in Section 4. A buried valley was uncovered following a geophysical survey, with intrusive investigation confirming the anomaly. Only two isolated instances of peat were encountered in historic and recent intrusive investigations, along with only one instance of slightly organic material.

In determining the feature importance of soft ground, the soil types have been grouped and are ranked in the **Table 9.11**.

Table 9.11: Geological Feature Importance for Geohazards within Study Area

Feature	Description	Feature Importance Ranking
GEOHZ01	Peat	Low
GEOHZ02	Soft Organic[13]	Low
GEOHZ03	Soft Non-Organic	Low

9.3.8 Contaminated Land

Various sources of information were consulted in assessing the study area for locations of potential contaminated land:

- CORINE land cover mapping
- Teagasc Soil map
- EPA
- Ground Investigation data

No known areas of contaminated ground were identified. Industrial sites may be the source of locally contaminated land due to site activities. Approximately 5% of the study area is comprised of Industrial and Commercial Units in accordance with the CORINE land cover mapping. However, these sites operate within the EPA Industrial Emissions (IE) licence framework and due to the regulated nature of their activities, the risk of contamination is low.

There are no sites within the study area that have been granted a waste water discharge licence.

Made ground has been defined as soil which has been altered in some way by human activity (imported and placed in-situ). Made ground has been observed in the form of inclusions of metal, glass, copper piping, ceramic piping. All locations of made ground are presented in the conceptual site model **Figure 9.8.001** to **Figure 9.8.012**. Based on the Teagasc Soil mapping less than 10% of the study area is comprised as made ground with approximately 30% of the study area comprised of artificial surfaces.

In 1996 the EPA began licensing certain activities in the waste sector which include landfills, transfer stations, hazardous waste disposal and other significant waste disposal and recovery activities. It has been determined from consultation with Galway County Council (29 August 2016) that there are no known historical (or legacy) landfills within the study area.

Section 1: Chainage 0+000 to 8+500

No known areas of contaminated ground were identified.

[13] Palaeolandscape fill is anticipated to be organic in nature, particularly due to the highly organic material encountered along the River Corrib and isolated instance at other locations identified to be overlaying palaeolandscape valleys. No organic testing has been conducted in the palaeolandscape fill in the project specific ground investigation.

CORINE and Teagasc subsoil mapping highlight areas of artificial surfaces due to residential dwellings, commercial properties and industrial usage.

One site was identified which previously had a Certificate of Registration for the importation of Construction and Demolition Waste. The certificate expired on the 28 May 2015.

Section 2: Chainage 8+500 to 9+400

No known areas of contaminated ground were identified.

CORINE and Teagasc subsoil mapping highlight areas of artificial surfaces due to residential dwellings, commercial properties, industrial usage and university buildings.

Section 3: Chainage 9+400 to 14+000

No known areas of contaminated ground were identified.

CORINE and Teagasc subsoil mapping highlight areas of artificial surfaces due to residential dwellings, commercial properties and industrial usage.

Section 4: Chainage 14+000 to 17+500

No known areas of contaminated ground were identified.

CORINE and Teagasc subsoil mapping highlight areas of artificial surfaces due to residential dwellings, commercial properties, sport and leisure facilities and industrial usage.

Three licenced IPPC facilities were identified in Section 4. These are tabulated in **Table 9.12** and are provided in in **Figure 9.7.001** to **Figure 9.7.002** and **Figure 9.7.101** to **Figure 9.7.114**.

Table 9.12: Geological Feature Importance for Contaminated Land within Study Area

Feature	Status / Extent in Percentage	Description	Location / General Extent	Feature Importance Ranking
Licensed IPPC Facilities				
IP01	Licensed	Medtronic Vascular Galway Ltd	Parkmore	Low
IP02	Surrendered	Irish Finishing Technologies Ltd	Ballybrit	Low
IP03	Licensed	Boston Scientific Ireland Ltd	Ballybrit	Low

9.3.9 Mineral / Aggregate Resources

Various datasets were consulted in establishing the economic geology of the study area including:

- GSI: aggregate potential mapping
- GSI: mineral localities
- EPA: active mine sites

These datasets are presented in **Figure 9.6.001** to **Figure 9.6.002** and **Figure 9.6.101** to **Figure 9.6.114**.

A detailed description of how the Aggregate Potential Mapping was developed is available in Issue No. 15 of Geology Matters as part of the Newsletter of the Geological Survey of Ireland or on the GSI website[14].

The existence of high or very high potential aggregate within the study area will result in a loss of available aggregate. However, such potential is beneficial during construction as material can be sourced on site removing the need to import suitable / acceptable material during the construction stage in its place.

No active metallic mines exist today in the study area. Over the past 50 years, parts of the area have been extensively prospected by mineral exploration companies for base metals, but no economically viable deposits have been discovered to date. There is no record of underground mining in the area therefore there would be a low risk of underground structure collapse due to underground excavations, and as such this assessment does not consider this feature any further.

Section 1: Chainage 0+000 to 8+500

The majority of Section 1 consists of very high crushed rock aggregate potential derived from granite with instances of high crushed rock aggregate potential at the beginning of Section 1, Na Foraí Maola, in the middle at An Chloch Scoilte and at the eastern end of Section 1 in Letteragh and Ballagh. Two instances of medium crushed rock aggregate potential were identified in Section 1, at An Chloch Scoilte and Dangan.

An area of low sand and gravel aggregate potential was identified in Rahoon.

All of the metallic mineral localities identified in the study area are located at the beginning of Section 1 in Na Foraí Maola.

One non-metallic locality was identified in An Chloch Scoilte which is described as low lying granite pavement. Four historic pits and one historic quarry were identified in the eastern extent of Section 1, between Keeraun and Dangan.

Section 2: Chainage 8+500 to 9+400

The majority of Section 2 consists of very high crushed rock aggregate potential with smaller instances of both high and moderate crushed rock aggregate potential.

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[14] The Aggregate Potential Mapping section of the Spring 2014 Newsletter of the Geological Survey of Ireland is available as pdf on the GSI website (https://www.gsi.ie/Newsletters/Aggregate+Potential+Mapping.htm)

The potential crushed rock in the limestone section is predominantly very high potential.

Section 3: Chainage 9+400 to 14+000

Section 3 is ultimately an area of very high crushed limestone rock aggregate potential with some very small, isolated instances of high potential.

One active (Roadstone Quarry at Twomileditch) and one disused quarry (Lackagh Quarry in Coolagh) are located in Section 3.

Section 4: Chainage 14+000 to 17+500

Section 4 is regarded as having very high crushed limestone rock aggregate potential. Two historic quarries and one historical gravel pit are located in Section 4.

Table 9.13: Geological Feature Importance of Mineral / Aggregate Resources within the Study Area

ID	Type	Description	Location / Extent	Feature Importance Ranking
Active Quarries				
Q01	Disused	Lackagh Quarry	Lackagh	Medium
Q02	Active	Roadstone Twomileditch Quarry	Polkeen	Very High
Active and Historic Quarries				
HPQ01	Historic	Sourced from OSI 6inch mapping	Keeraun	Low
HPQ02	Historic	Sourced from OSI 6inch mapping	Keeraun	Low
HPQ03	Historic	Sourced from OSI 6inch mapping	Keeraun	Low
HPQ04	Historic	Sourced from OSI 6inch mapping	Letteragh	Low
HPQ05	Historic	Sourced from OSI 6inch mapping	Ballagh	Low
HPQ06	Historic	Sourced from OSI 6inch mapping	Ballybrit	Low
HPQ07	Historic	Sourced from OSI 6inch mapping	Ballybrit	Low
HPQ08	Historic	Sourced from OSI 6inch mapping	Parkmore	Low
Aggregate Potential				
VHPCR	Crushed Rock	Very high crushed rock aggregate potential	Entire Study Area (89%)	Very High
HPCR	Crushed Rock	High crushed rock aggregate potential	Na Foraí Maola, An Chloch Scoilte,	High

ID	Type	Description	Location / Extent	Feature Importance Ranking
			Rahoon, Letteragh, Dangan (10%)	
MPCR	Crushed Rock	Moderate crushed rock aggregate potential	An Chloch Scoilte, Dangan (1%)	Medium
LPSAGR	Sand and Gravel	Low sand and gravel aggregate potential	Rahoon and Ballybrit	Low
Mineral Localities				
ML01	Metallic	Copper	Na Foraí Maola	Low
ML02	Metallic	Iron	Na Foraí Maola	Low
ML03	Metallic	Molybdenum	Na Foraí Maola	Low
ML04	Metallic	Iron	Na Foraí Maola	Low
ML05	Metallic	Molybdenum	Na Foraí Maola	Low
ML06	Metallic	Copper	Na Foraí Maola	Low
ML07	Metallic	Copper	Na Foraí Maola	Low
ML08	Metallic	Iron	Na Foraí Maola	Low
ML09	Metallic	Molybdenum	Na Foraí Maola	Low
ML10	Metallic	Iron	Na Foraí Maola	Low
ML11	Metallic	Copper	Na Foraí Maola	Low
ML12	Metallic	Copper	Na Foraí Maola	Low
ML13	Metallic	Iron	Na Foraí Maola	Low
ML14	Metallic	Molybdenum	Na Foraí Maola	Low
ML15	Metallic	Copper	Na Foraí Maola	Low
ML16	Metallic	Iron	Na Foraí Maola	Low
ML17	Metallic	Fluorspar	Na Foraí Maola	Low
ML18	Non-Metallic	Low lying Granite pavement	An Chloch Scoilte	Low
ML19	Non-Metallic	Disused Granite Quarry	Letteragh	Low
ML20	Non-Metallic	Disused Granite Quarry	Ballagh	Low
ML21	Non-Metallic	Dimension stone	Lackagh Quarry, Coolagh	Low
ML22	Non-Metallic	Limestone (in general)	Lackagh Quarry, Coolagh	Low
ML23	Non-Metallic	Dimension stone	Roadstone Quarry, Twomileditch	Very High
ML24	Non-Metallic	Limestone (in general)	Roadstone Quarry, Twomileditch	Very High

9.3.10 Geological Heritage Areas

The Irish Geological Heritage Programme is a partnership between the GSI and the National Parks and Wildlife Service (NPWS). The programme was developed to identify, document the geological heritage and protect and conserve it. Consultation was conducted with the GSI in order to identify all geological heritage sites within the study area.

The Galway County Development Plan (2015-2021) states that it is a Natural Heritage and Biodiversity policy (NHB 2) to recognise that nature conservation is not just confined to designated sites and acknowledge the need to protect non-designated habitats and landscapes and also (NHB 5) to protect, conserve and enhance important geological and geo-morphological systems in the county and seek to promote access to such sites where possible.

Consideration was given to Table 4.3 Network of Local Biodiversity Areas and Table 4.4 Other Areas/Features of Local Importance in the City from the Galway City Council Development Plan 2017-2023.

Section 1: Chainage 0+000 to 8+500

Igneous intrusions (GHA06) and observable magma mingling are located at the very beginning of Section 1, on the coastal side of the R336.

Section 2: Chainage 8+500 to 9+400

No geological heritage sites have been identified in Section 2.

Section 3: Chainage 9+400 to 14+000

Roadstone Quarry (GHA01) is located at Twomileditch in Section 3.

Section 4: Chainage 14+000 to 17+500

No geological heritage sites have been identified in Section 4.

Table 9.14: Geological Feature Importance of Heritage Areas within Study Area

ID	Site Name	Principle Characteristic	Feature Importance Ranking
GHA01	Roadstone Quarry on Tuam Road	Heritage / large existing quarry. Limestone quarry producing aggregates, agricultural ground limestone and concrete	Very High
GHA06	Igneous Intrusions	Observable magma mingling	Very High

9.3.11 Summary of Geological Feature Importance

A summary of the geological features with an importance of medium or higher found within the study area, are presented below in **Table 9.15**.

Table 9.15: Summary of Geological Features

ID	Feature Name / ID	Description / Location	Feature Importance Ranking
Agricultural Soils			
AminDW	Deep well drained non-calcareous soil	Deep well drained non-calcareous soil. Widespread in Section 1	High
AminSW	Shallow well drained non-calcareous soil	Shallow well drained non-calcareous soil. Widespread in Section 1	High
BminDW	Deep well drained calcareous soil	Deep well drained calcareous soil. Widespread in Section 3 and 4	High
BminSW	Shallow well drained calcareous soil	Shallow well drained calcareous soil. Widespread in Section 3 and 4	High
Karst Features			
LP	Limestone pavement	Widespread across Section 3 and 4	Very High
PK	Palaeokarst Valley	Menlough, Ballindooley, Castlegar	Medium
K7	Spring	Bushypark	Medium
K10	Enclosed Depression	Bushypark	Medium
K11	Enclosed Depression	Bushypark	Medium
K12	Enclosed Depression	Bushypark	Medium
K17	Spring	Menlough	Medium
K25	Spring	Menlough	Medium
K31	Turlough	Menlough	Medium
K44	Enclosed Depression	Coolagh	Medium
K45	Spring	Coolagh	Medium

ID	Feature Name / ID	Description / Location	Feature Importance Ranking
K49	Enclosed Depression	Coolagh	Medium
K51	Enclosed Depression	Coolagh	Medium
K54	Enclosed Depression	Coolagh	Medium
K57	Enclosed Depression	Coolagh	Medium
K59	Enclosed Depression	Coolagh	Medium
K61	Enclosed Depression	Coolagh	Medium
K62	Enclosed Depression	Coolagh	Medium
K64	Enclosed Depression	Coolagh	Medium
K67	Enclosed Depression	Coolagh	Medium
K70	Enclosed Depression	Coolagh	Medium
K71	Enclosed Depression	Coolagh	Medium
K97	Enclosed Depression	Castlegar	Medium
K104	Enclosed Depression	Castlegar	Medium
K131	Enclosed Depression	Parkmore	Medium
K158	Spring	Coolagh	Medium
K161	Spring	Coolagh	Medium
K166	Spring	Coolagh	Medium
K172	Enclosed Depression	Coolagh	Medium
K175	Enclosed Depression	Coolagh	Medium
K176	Spring	Coolagh	Medium
K178	Spring	Coolagh	Medium
K179	Enclosed Depression	Coolagh	Medium
K180	Spring	Coolagh	Medium
K181	Spring	Coolagh	Medium
K193	Enclosed Depression	Coolagh	Medium

ID	Feature Name / ID	Description / Location	Feature Importance Ranking
K328	Enclosed Depression	Parkmore	Medium
Aggregate / Resource Potential			
Q01	Lackagh Quarry - Disused	Coolagh	Medium
Q02	Roadstone Quarry	Twomileditch	Very High
VHPCR	Crushed Rock	Very high crushed rock aggregate potential. Entire Study Area.	Very High
HPCR	Crushed Rock	High crushed rock aggregate potential. Na Foraí Maola, An Chloch Scoilte, Rahoon, Letteragh, Dangan.	High
MPCR	Crushed Rock	Moderate crushed rock aggregate potential. An Chloch Scoilte, Dangan.	Medium
ML23	Roadstone Dimension Stone	Twomileditch	Very High
ML24	Roadstone Limestone (in general)	Twomileditch	Very High
Geological Heritage			
GHA01	Roadstone Quarry on Tuam Road	Heritage / large existing quarry. Limestone quarry producing aggregates, agricultural ground limestone and concrete	Very High
GHA06	Igneous Intrusions	Observable magma mingling in Bearna	Very High

9.3.12 Conceptual Site Model

A conceptual site model was developed based on the ground investigation data. The model includes the factual data within the study area that was gathered during the ground investigations. The information is presented on **Figure 9.8.001** to **Figure 9.8.012** in plan and profile format with the profile illustrating the existing and proposed ground levels, earthwork sections, local ground investigation logs and geophysical data along the centre-line of the proposed road development. See also **Appendix A.9.1** for all ground investigation data.

The earthworks areas of cut and fill are presented in **Figure 9.8.001** to **Figure 9.8.012** and in **Table 9.16** below. The embankment height (average and maximum, cut height (average and maximum) and the soils and geology at each earthwork areas are presented in **Table 9.16**.

Table 9.16: Earthwork Areas of Cut and Fill

Earthwork Reference	Dominant Earthworks Type	Environment Section	Length (m)	Max Fill (m)	Average Fill (m)	Max Cut (m)	Average Cut (m)	Generalised Overburden and Bedrock Description	Average Depth to Rock (mBGL)
EW01	Cut	Section 1 Na Foraí Maola	460	1.63	0.14	-3.13	-1.06	Peat over granite derived glacial gravels with areas of made ground over granite bedrock	0.50
EW02	Fill	Section 1 Na Foraí Maola to An Chloch Scoilte	2270	5.38	1.65	-3.34	-0.22	Peat over granite derived glacial gravels and some deposits of cohesive glacial till with areas of made ground over granite bedrock	0.60
EW03	Fill	Section 1 Ballard West	280	5.66	2.47	0	0	Peat over granite derived glacial gravels over granite bedrock	0.50
EW04	Cut	Section 1 Ballard	800	3.61	0.06	-6.97	-3.86	Peat over granite derived glacial gravels over granite bedrock	0.50
EW05	Fill	Section 1 Aille	530	6.47	2.41	-2.20	-0.17	Peat over granite derived glacial gravels with isolated instances of made ground and possibly alluvial deposits near stream. Area overlying granite bedrock	0.80
EW06	Fill	Section 1 Cappagh	820	4.31	1.53	-2.45	-0.27	Peat over granite derived glacial gravels over granite bedrock	1.40
EW07	Cut	Section 1 Ballyburke	350	2.66	0.28	-8.91	-2.18	Granite derived glacial gravels over granite bedrock	1.00

Earthwork Reference	Dominant Earthworks Type	Environment Section	Length (m)	Max Fill (m)	Average Fill (m)	Max Cut (m)	Average Cut (m)	Generalised Overburden and Bedrock Description	Average Depth to Rock (mBGL)
EW08	FILL	Section 1 Ballymoneen to Letteragh	1550	11.78	3.40	-6.79	-0.25	Peat over granite derived glacial gravels with areas of made ground over granite bedrock	1.30
EW09	FILl	Section 1 Knocknafroska / Knocknabrona	300	10.12	7.54	0.00	0.00	Peat over granite derived glacial gravels over granite bedrock	2.70
EW10	FILL	Section 1 Knocknafroska / Knocknabrona	300	6.98	2.73	-4.28	-0.84	Peat over granite derived glacial gravels over granite bedrock	4.50
EW11	CUT	Section 1 Knocknafroska / Knocknabrona	400	0.00	0.00	-14.89	-8.49	Peat over granite derived glacial gravels over granite bedrock	2.60
EW12	CUT	Section 1 Upper Dangan	150	1.62	0.17	-6.89	-3.05	Granite derived glacial gravels over granite bedrock	2.20
EW13	FILL	Section 1 and 2 Dangan	550	9.70	5.03	-1.35	-0.04	Granite derived glacial gravels with areas of made ground over granite bedrock	3.00
EW14	FILL	Section 2 Dangan to River Corrib	450	16.60	10.65	0.00	0.00	Deposits of limestone derived cohesive glacial till over glacial gravels with areas of made ground over limestone bedrock	5.50

Earthwork Reference	Dominant Earthworks Type	Environment Section	Length (m)	Max Fill (m)	Average Fill (m)	Max Cut (m)	Average Cut (m)	Generalised Overburden and Bedrock Description	Average Depth to Rock (mBGL)
EW15	RIVER CORRIB STRUCTURE	Section 2 River Corrib	200	No Cut / Fill due to existence of structure				Deposits of limestone derived cohesive glacial till over glacial gravels with some isolated alluvial deposits present along the River Corrib	n/a[15]
EW16	FILL	Section 3 Menlough	600	19.37	10.01	0.00	0.00	Peat over limestone derived cohesive glacial till with isolated instances of made ground and alluvial deposits. Identified location of palaeokarst valleys Area overlying limestone bedrock	2.30
EW17	MENLOUGH VIADUCT	Section 3 Menlough	330	No Cut / Fill due to existence of structure				Deposits of limestone derived cohesive glacial till over glacial gravels with some alluvial deposits over limestone bedrock	0.00[16]
EW18	FILL	Section 3 Menlough	380	10.01	3.73	-4.09	-0.12	Deposits of limestone derived cohesive glacial till over glacial gravels mixed with Limestone pavement Identified location of palaeokarst valleys Area overlying limestone bedrock	1.80
EW19	CUT	Section 3 Coolagh	330	4.76	0.34	-15.46	-6.45	Deposits of limestone derived cohesive glacial till over glacial gravels Identified location of palaeokarst valleys Area overlying limestone bedrock	55.00[17]

[15] Depth to rockhead is unavailable over the extent of the River Corrib as no intrusive investigation was conducted.

[16] Some overburden including topsoil exists along the extents of the structure. However, the majority of the area consists of outcropping Limestone pavement. Therefore, the average depth has been provided as 0m to reflect the typically shallow rock.

[17] The change in rockhead, based on intrusive and geophysical ground investigation, is quite significant in this area, with the maximum depth recorded of 109m below ground level. However, this maximum depth is quite isolated with the rockhead typically quite shallow.

Earthwork Reference	Dominant Earthworks Type	Environment Section	Length (m)	Max Fill (m)	Average Fill (m)	Max Cut (m)	Average Cut (m)	Generalised Overburden and Bedrock Description	Average Depth to Rock (mBGL)
EW20	LACKAGH TUNNEL	Section 3 Coolagh	280	No Cut / Fill due to existence of structure				Shallow deposits of limestone cohesive glacial till mixed with Limestone pavement Identified location of palaeokast valleys. Area overlying limestone bedrock	0.00[18]
EW21	FILL	Section 3 Coolagh	300	10.67	4.98	-7.49	-0.55	Deposits of limestone derived cohesive glacial till with areas of made ground over limestone bedrock	0.00[19]
EW22	CUT	Section 3 Ballindooley	200	11.82	4.06	-24.64	-8.60	Deposits of limestone derived cohesive glacial till over glacial gravels over limestone bedrock	3.50
EW23	FILL	Section 3 Ballindooley	270	9.47	3.72	-7.97	-0.75	Limestone derived cohesive glacial till / glacial gravels with areas of made ground Identified location of palaeokarst valleys Area overlying limestone bedrock	10.50
EW24	FILL	Section 3 Ballindooley	310	16.28	10.94	0.00	0.00	Peat over limestone derived cohesive glacial till / glacial gravels Identified location of palaeokarst valleys Area overlying limestone bedrock	7.00
EW25	CUT	Section 3 Castlegar	420	9.49	0.70	-7.61	-4.03	Deposits of limestone derived cohesive glacial till. Identified location of palaeokarst valleys Area overlying limestone bedrock	2.80

[18] While topsoil exists in some of the extent of this earthwork area, the majority consists of outcropping Limestone pavement. This gave rise to the construction of a tunnel through the rock. Therefore, the average depth to rockhead has been indicated as 0m in order to reflect this environment.

[19] This earthworks area extends along the floor of the disused Lackagh Quarry. Therefore, the depth to rockhead has been provided as zero.

Earthwork Reference	Dominant Earthworks Type	Environment Section	Length (m)	Max Fill (m)	Average Fill (m)	Max Cut (m)	Average Cut (m)	Generalised Overburden and Bedrock Description	Average Depth to Rock (mBGL)
EW26	FILL	Section 3 Castlegar	130	8.17	2.79	-4.35	-0.70	Deposits of limestone derived cohesive glacial till with areas of made ground Identified location of palaeokarst valleys Area overlying limestone bedrock	14.30
EW27	CUT	Section 3 Castlegar	600	7.85	0.26	-12.65	-7.58	Deposits of limestone derived cohesive glacial till with areas of made ground Identified location of palaeokarst valleys Area overlying limestone bedrock	5.90
EW28	FILL	Section 3 and 4 N83 Tuam Road	500	12.65	7.52	-3.70	-0.12	Deposits of limestone derived cohesive glacial till with areas of made ground Identified location of palaeokarst valleys Area overlying limestone bedrock	17.80
EW29	CUT	Ballybrit	300	5.66	0.32	-12.84	-8.85	Deposits of limestone derived cohesive glacial till over limestone bedrock	2.70
EW30	CUT	Ballybrit	500	0.00	0.00	-11.20	-8.85	Deposits of limestone derived cohesive glacial till with areas of made ground over limestone bedrock	7.50
EW31	GALWAY RACECOURSE TUNNEL	Galway Racecourse	240	0.00	0.00	-9.52	-8.63	Deposits of limestone derived cohesive glacial till with areas of made ground over limestone bedrock	6.30
EW32	CUT	Ballybrit	310	1.73	0.11	-9.52	-4.64	Deposits of limestone derived cohesive glacial till over limestone bedrock	4.60

Earthwork Reference	Dominant Earthworks Type	Environment Section	Length (m)	Max Fill (m)	Average Fill (m)	Max Cut (m)	Average Cut (m)	Generalised Overburden and Bedrock Description	Average Depth to Rock (mBGL)
EW33	FILL	Briarhill	700	8.43	5.08	-0.98	-0.03	Deposits of limestone derived cohesive glacial till with areas of made ground over limestone bedrock	2.40
EW34	CUT	Briarhill	700	2.82	0.22	-7.44	-2.46	Deposits of limestone derived cohesive glacial till over limestone bedrock	1.90
EW35	CUT	Ardaun, Coolagh	640	1.34	0.11	-9.48	-2.35	Deposits of limestone derived cohesive glacial till with areas of made ground over limestone bedrock	2.00
N59 LINK	CUT/FILL	Letteragh	2170	8.77	0.91	-12.99	-2.25	Peat over granite derived glacial gravels with areas of made ground over limestone bedrock	2.10

9.4 Characteristics of the Proposed Road Development

A detailed description of the proposed road development and construction activities are provided in **Chapter 5, Description of Proposed Road Development** and **Chapter 7, Construction Activities**.

This section of the report outlines the key design features and the construction and operational characteristics and activities of the proposed road development of relevance to soils and geology. The potential impacts related to such construction activities are provided in **Section 9.5**.

9.4.1 Key Design Features

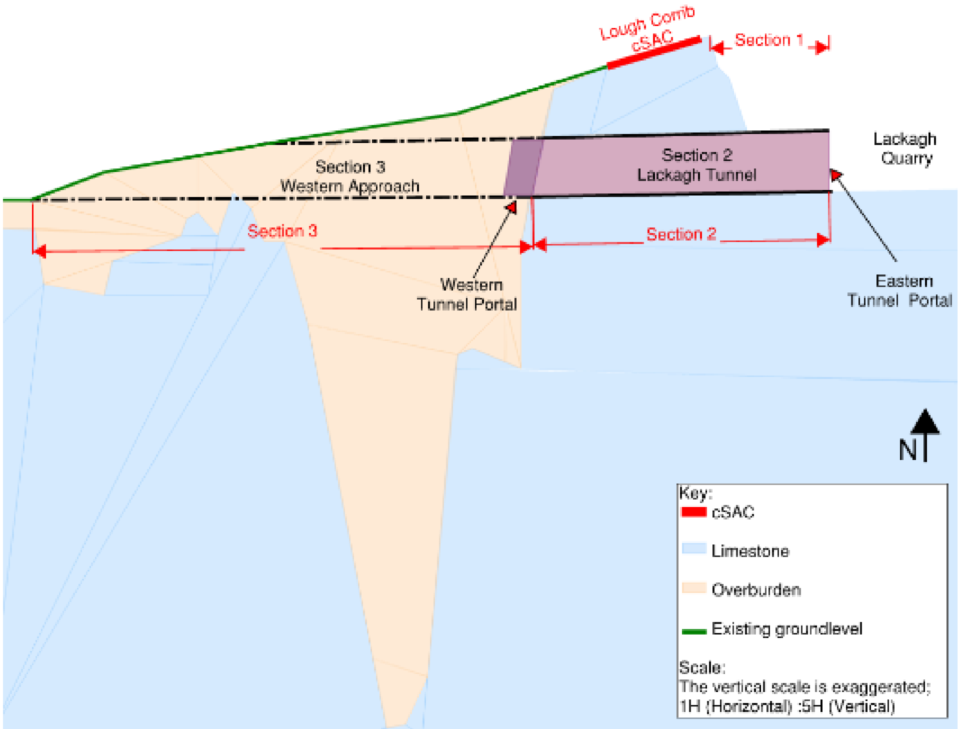
The key design measures of relevance to avoid or reduce impact to soils and geology features, in particular Limestone pavement, are:

- Lackagh Tunnel and the Western Approach
- Menlough Viaduct and Culvert
- Reinforced / retained slopes

9.4.1.1 Lackagh Tunnel and the Western Approach

Lackagh Tunnel comprises of three sections between Ch. 10+775 to Ch. 11+420 of the proposed road development namely Section 1 Lackagh Quarry Face, Section 2 Lackagh Tunnel and Section 3 Western Approach, refer to **Plate 9.1**.

Plate 9.1: Schematic cross section of Sections 1-3 at Lackagh Tunnel



Lough Corrib cSAC which includes Limestone pavement is located immediately west of Section 1. Section 2, Lackagh Tunnel (ST11/01) is a drill and blast mined twin bored tunnel approximately 270m long, from Ch. 11+150 to Ch. 11+420. Section 2 tunnels beneath Lough Corrib cSAC, including Limestone pavement, between approximately Ch. 11+240 and Ch. 11+350. Section 3 lies partially within the Lough Corrib cSAC and traverses between areas of Limestone pavement which is located north and south of the proposed road development.

Given the presence of Limestone pavement, the potential geological impacts of Lackagh Tunnel and its immediate approaches on limestone pavement include:

- Rock mass instability and slope instability in Sections 1 and 3 resulting in potential encroachment onto Limestone pavement within Lough Corrib cSAC, due to its proximity to the proposed road development
- Blasting activities required for the construction of Sections 2 and 3 resulting in potential impact on the structural integrity of the Limestone pavement
- Collapse of the tunnel and ground settlement from the tunnel bore in Section 2 resulting in potential impact on the Limestone pavement within Lough Corrib cSAC

To avoid these geological impacts the following measures are included in the design of Lackagh Tunnel and its approaches (Sections 1, 2 and 3) along with a conservative design approach:

- In Section 1, stabilisation of Lackagh Quarry face will be carried out around the eastern tunnel portal in order to prevent rock mass instability and slope instability. The conservative design approach requires that stabilisation of the Lackagh Quarry face (western face of the quarry) around the eastern tunnel portal will be completed in advance of tunnelling works for Section 2 (Lackagh Tunnel). These stabilisation works include a composite support system of rock bolts, rock dowels, steel mesh and sprayed concrete

- Section 2 is a mined twin bore tunnel in rock constructed using a drill and blast methodology. This method of construction is commonly used for tunnels of this length through hard rock. The conservative design approach of Section 2 requires the following the tunnel design elements to ensure that collapse of the tunnel and ground settlement does not arise:
  - At least 8.0m of clear bedrock is required above the crown of the tunnel bore to the top of the Limestone pavement ground surface in order to maintain the bore stability. This design requirement is achieved in the Lackagh Tunnel design with the proposed alignment providing bedrock cover ranging from ~10m to 14.5m above the crown of the tunnel to the Limestone pavement ground surface
  - A 7m wide separation pillar is required between the two bores in order to maintain the twin bore stability. This design requirement has also been achieved in the Lackagh Tunnel design with the proposed alignment allowing for a rock pillar of 7.3m between the two bores
- In Sections 2 and 3, to prevent rock mass instability, rock mapping assessments will be completed by a geotechnical expert following each tunnel blast in Section 2, rock blast in Section 3 and during the excavation of the Section 3. The outcome of these assessments will govern which rock stability design solution and tunnel design support measure to be employed
- In Section 3, retaining systems will be implemented at pinch points along the Western Approach to support the cut face between existing ground level and the proposed road level preventing slope instability and encroachment onto Limestone pavement. The conservative design approach includes the following retaining systems:
  1. Rock bolts, rock dowels, steel mesh, and sprayed concrete in areas of rock only
  2. Piled retaining walls, supported with ground anchors in areas of overburden only and in areas with a combination of overburden and rock that will be monitored during construction and compared with the design
- In all sections blast design limitations, these include a maximum vibration limit of 25mm/sec, a construction target vibration limit of 20mm/sec which is less than the maximum vibration limit and a monitored trial blast undertaken in the same bedrock formation by the blasting contractor in a controlled location that will pose no risk to sensitive receptors. The trial blast will not exceed the vibration limitations of the local sensitive receptors. The information obtained from the trial blast will calibrate and refine the blast design to a site specific design.

The tunnel construction activity is outlined in **Section 9.4.2.5**, potential construction and operational impacts are outlined in **Section 9.5.3.4** and **9.5.4** with mitigation measures presented in **Section 9.6**. Refer to **Chapter 8, Biodiversity** for the ecological assessment and **Chapter 10, Hydrogeology** for the hydrogeology assessment.

Further details on Lackagh Tunnel can be found in **Appendix A.7.1**.

9.4.1.2 Menlough Viaduct and Culvert

The design includes a viaduct structure, Menlough Viaduct (ST10/01) from Ch. 10+100 to Ch. 10+420. The total length of the viaduct is governed by the area of Limestone pavement and a Turlough (karst feature ID code K31), which are both located outside of the Lough Corrib cSAC. The viaduct has a total length of approximately 320m, and the proposed road development is on embankment on both approaches to it. The viaduct contains eight spans of a similar 40m span length. The span lengths have been adjusted to minimise the substructure and foundation footprint on the Limestone pavement and avoid the extent of the Turlough.

There is a culvert in Menlough that is also included in the design from approximately Ch. 10+025 to Ch. 10+050. This structure spans Limestone pavement surface (outside of the Lough Corrib cSAC) avoiding the removal of the feature at this location.

9.4.1.3 Reinforced Slopes

The retaining wall in the Menlough area (between Ch. 9+850 and Ch. 10+050) is located adjacent to the Lough Corrib cSAC. This structure will be constructed to retain the embankment of the proposed road development from encroachment on the Annex I habitat of the Lough Corrib cSAC including Limestone pavement. The construction of the retaining wall will be undertaken within the proposed development boundary and outside the areas of Annex I habitat.

9.4.2 Construction activities

As discussed in **Chapter 7, Construction Activities**, it is envisaged that an east to west build will be adopted for the construction of the proposed road development and it may be completed in two concurrent phases or a single overall contract. The two phases are:

- Phase 1 – N6 Coolagh to N59 Letteragh Junction – 9.9km (Including the N59 Link Road North and South)
- Phase 2 – N59 Letteragh Junction – R336 West of Bearna 7.5km

The construction activities involved in the proposed road development relevant to soils and geology are listed below and further discussed in the following sub-sections, **Sections 9.4.2.1** to **9.4.2.10**. The construction activities relevant to soils and geology include:

- Embankment construction
- Excavation of cuts
- Soil and rock slopes

- Reuse and processing of site material
- Importation, exportation and disposal of materials
- Tunnelling
- Construction of foundations for structures
- Contaminated ground
- Soft Soil
- Karst features
- Dewatering

A Construction Environmental Management Plan (CEMP) is provided in **Appendix A.7.5**.

9.4.2.1 Embankment construction

As outlined in the conceptual site model in **Figures 9.8.001** to **9.8.012** and **Table 9.16**, certain areas along the proposed road development will require the placement of fill material to achieve the proposed alignment level. These embankment sections will be formed using imported fill or site won[20] material. The imported fill will be transported on site access roads using trucks and on routes outlined in **Chapter 7, Construction Activities**.

For embankments less than 3.0m in height, topsoil will require removal from beneath the embankment footprint. For areas identified as medium and high karst risk, topsoil will require removal in order to proof roll the underlying material. Topsoil will be excavated, transported and stored at a designated stockpile on site and reused for landscaping across the proposed road development.

Material evaluated to be soft beneath the footprint of the embankment will be removed in order to provide a more suitable founding strata. Bituminous or hard standing material will also be removed.

The potential impact from this construction activity are discussed in **Section 9.5.3.1.**

9.4.2.2 Excavation of cuts

Where the proposed road level is below the existing ground level, existing material will require excavation and removal. As outlined in **Table 9.16**, these cut areas along the proposed road development will require the removal of overburden (fertile soil, soft soils, made ground, superficial deposits) and bedrock (granite and limestone).

Based on the factual ground investigation information available, for cuts in rock, hard ripping using a hydraulic hammer or blasting of the bedrock will be required.

[20] Material which has been recovered as part of the construction excavation activities. If purposed for use in embankment construction, the material must comply with material properties and constituents outlined in the TII Series 600 Earthworks Specification.

See **Appendix A.9.1** for ground investigation data. All other excavation, and removal of broken or blast rock, will be completed using an excavator and transported to other areas of the site or to a designated disposal site. Topsoil will be excavated, transported, stored at a designated stockpile on site and reused for landscaping across the proposed road development. See details in relation to waste in **Chapter 7, Construction Activities**.

As part of the blast design assessment monitored trial blasts in the same bedrock formation as the proposed blast locations at locations of proposed blasting will be conducted. These trial blasts will calibrate the blast design to site specific designs and will refine and validate the blast design properties. Trial blasts will not exceed the limitations of the local sensitive receptors.

Excavations are typically undertaken in a ‘dry’ environment, therefore cuts that intercept the groundwater table may require temporary dewatering, if permitted. These locations are outlined and assessed in **Chapter 10, Hydrogeology**.

The potential impacts related to this activity are further discussed in **Section 9.5.3.1**.

9.4.2.3 Reuse and processing of site material

Site won material, obtained from cuttings, will where possible be reused as fill for the construction of embankments and other elements along the proposed road development. Crushing and processing of suitable material obtained on site during the earthworks for re-use will be employed insofar as is possible.

The potential impacts related to this activity are discussed in **Section 9.5.3.2**.

9.4.2.4 Importation, exportation and disposal of materials

Earthworks quantities along the proposed road development are subdivided into a number of earthworks sections based upon natural physical boundaries such as rivers and existing roads. The estimated quantities of imported and exported fill within these areas are outlined in **Chapter 7, Construction Activities**.

The construction of Phase 1 will result in a surplus of material however in the unlikely event that the construction of Phase 2 is first this will result in a deficit of acceptable material.

The deficit of aggregate will require the importation of suitable material. Material shall be sourced from quarries which are listed on the register maintained by the local authority. Designated haulage routes and access routes have been identified and are further discussed in **Chapter 7, Construction Activities**.

In line with the principles of sustainable development, the proposed road development will minimise the amount of materials brought into the construction site. This will be achieved by re-using as much of the materials generated during construction as possible subject to further testing to determine if materials meet the specific engineering standards for their proposed end-use.

Where the excavation contains a combination of acceptable and non-acceptable material for reuse, the excavation will be conducted so that acceptable material is excavated separately without contamination by the unacceptable material.

Any hazardous material, as evaluated from appropriate environmental testing, will result in the necessity for off-site disposal to designated disposal sites in accordance with all relevant legislation. This is further discussed in **Chapter 7, Construction Activities**.

The potential impacts related to this activity are further discussed in **Section 9.5.3.3**.

9.4.2.5 Tunnelling

Two tunnels are proposed along the proposed road development as follows:

- Mined Tunnel at Coolough, Menlough (Lackagh Tunnel– Approximately 270m tunnel through limestone bedrock and overburden)
- Cut and Cover at Ballybrit (Galway Racecourse Tunnel – Approximately 230m tunnel in limestone bedrock)

Mined Tunnel

The proposed mined tunnel, Lackagh Tunnel, comprises two bores for the eastbound and westbound carriageways of the proposed road development. Each bore comprises an approximately 15m wide span tunnel with water tight concrete arch lining with the internal elements (road, walkways, lighting, ventilation etc.) placed within this shell. The proposed alignment for Lackagh Tunnel provides bedrock cover ranging from approximately 10m to 14.5m above the tunnel crown below the Limestone pavement surface.

The tunnel excavation, in Menlough, will be a mined tunnel (drill and blast), which is commonly used for tunnels through hard rock. The tunnel commences in Lackagh Quarry at the tunnel portals using drill and blast methods. Excavation progresses for the tunnel in a cyclic manner with drilling, blasting, rock face mapping, mucking out, installation of support measures and then preparing for the next advance of the tunnel.

Further details on Lackagh Tunnel can be found in **Appendix A.7.3**.

Cut and Cover Tunnel

The cut and cover tunnel, Galway Racecourse Tunnel, will consist of 230m twin box construction, with a maximum depth of approximately 11m below ground level, with all elements constructed using cast in-situ reinforced concrete or precast concrete box units, which are assembled longitudinally and transversely from discrete precast elements.

The tunnel excavation will be undertaken from ground level. The overburden will be excavated, followed by blasting of the bedrock in order to break it prior to excavation. Rock excavation will progress in a cyclic manner with drilling blast holes, blasting, rock face mapping and mucking out.

The potential impacts related to tunnelling are further discussed in **Section 9.5.3.4**.

9.4.2.6 Construction of Structures

The proposed road development requires the construction of a number of structures. The proposed structures are discussed in **Chapter 5, Description of Proposed Development**.

In general, foundations are likely to require shallow solutions which require a limited, shallow excavation at the footing locations. However, depending on the structure and the ground conditions encountered, some areas will require a more robust solution, which may include:

- Pile foundation in areas of poor, soft ground or in areas of high karst risk
- Earth retaining structures in areas where soil must be restrained at unnatural slopes
- Excavate and replace at footing locations due to karst risk, to expose rock surface in areas underlain by limestone

From existing ground information, the structures identified in **Table 9.17** will likely require deep or a specialised foundation solution due to ground conditions or karst risk.

The potential impacts related to this activity are further discussed in **Section 9.5.3.5**.

Table 9.17: Structures requiring specialised foundation solutions

Reference	Assessment Section	Name / Function	Approx. Chainage
S08/04	2	River Corrib Bridge Structure	9+300
C09/01	3	Culvert	9+520
C09/02	3	Culvert	9+560
C09/03	3	Culvert	9+580
C09/04	3	Culvert	9+590
C09/05	3	Culvert	9+600
S09/03	3	Accommodation Underpass S09/03	9+910
C10/01	3	Local access Underpass	10+060
S10/01	3	Menlough Viaduct	10+110
S12/01	3	N84 Headford Road Underbridge	12+150
C12/02	3	Culvert	12+350
C12/03	3	Culvert	12+390
C12/04	3	Culvert	12+450
C13/01	3	Mammal Underpass	12+980
C13/02	3	Mammal Underpass	13+700
S13/02	3 / 4	N83 Tuam Road Underbridge (WB merge)	13+925
S13/03	3 / 4	N83 Tuam Road Underbridge (Mainline and EB diverge)	13+975
S15/02	4	Briarhill Business Park Underbridge	15+725

Reference	Assessment Section	Name / Function	Approx. Chainage
S15/03	4	Monivea Road R339 Underbridge	15+880

9.4.2.7 Contaminated ground

Ground investigation information along with the current and historical site activities indicated the potential locations of contamination. These included areas adjacent to existing road networks, infrastructure networks, man-made drainage systems and general built construction.

No areas of contamination were identified during the investigations. See conceptual site model in **Figure 9.8.001** to **Figure 9.8.012**. While areas of contamination are unlikely, out of an abundance of caution, all potential locations will be further investigated during construction and the makeup of the ground evaluated. Any shallow made ground deposits will be excavated and replaced.

Hazardous material removed as part of the excavation may require specialist disposal to designated disposal sites. This is further discussed in **Chapter 7, Construction Activities**.

The potential impacts related to this activity are further discussed in **Section 9.5.3.6**.

9.4.2.8 Soft soil

Soft soil, which includes both peat and soft organic clay / silt, exist across the study area. Typically, peat is present in the western section, underlain by granite, while the limestone area has soft organic and alluvial material. Soft ground areas have been identified and are indicated in **Figure 9.7.001** to **Figure 9.7.002** and **Figure 9.7.101** to **Figure 9.7.114**.

Areas of shallow deposits will likely be excavated and removed. Deeper soft soil deposits may require excavation or in-situ ground improvement.

The potential impacts related to this activity are further discussed in **Section 9.5.3.7**.

9.4.2.9 Karst Features

In Sections 2, 3 and 4, from the N59 Moycullen Road at Dangan to the existing N6 at Coolagh, Briarhill the proposed road development overlies Visean Limestone which is prone to karst. The proposed road development subsequently crosses numerous karst features. Identified surface karst features are presented in **Table 9.10**.

Certain anomalies were encountered during the ground investigation in the area underlain by karstified limestone, refer to **Appendix A.9.1** for all ground investigation data and **Figures 9.8.001** to **9.8.012**.

The hydrogeology of karst features is dealt with in **Chapter 10, Hydrogeology**.

9.4.2.10 Dewatering

The ground investigation data suggests that groundwater will be encountered in some areas of cut and for a number of foundation excavations, refer to **Chapter 7, Construction Activities**. Dewatering is required where significant ingress of water will occur during construction.

The potential impacts of this dewatering and dewatering limitations are assessed and presented in **Chapter 10, Hydrogeology**.

9.4.3 Operational activities

The proposed road development will require periodic maintenance of the development, embankment slopes, cut slopes, tunnels and drainage channels.

9.5 Evaluation of Impacts

9.5.1 Introduction

An appraisal of the potential impacts to geological features and of construction activities was undertaken in accordance with the TII Guidelines (NRA, 2009) considerations as presented in **Section 9.2.5** of this chapter. The evaluation and corresponding impact significance for geological features are presented and summarised in **Table 9.19** for the Construction Phase and **Table 9.20** for the Operational Phase. **Section 9.5.3** and **9.5.4** describes the potential construction and operational activity impacts respectively on soils and geology pre-mitigation.

9.5.2 Do-Nothing Scenario

In the case where the proposed road development was not to be developed there would be no resulting impacts on the soils or geology along the route of the proposed road development. The impact would therefore be *neutral*.

9.5.3 Construction Phase Impacts

The potential soils and geology impacts during the construction phase for each construction activity described in **Section 9.4** are presented in this section, along with their impact significance. These potential impacts also relate to and interact with other environmental factors which are described within the EIAR. Specific interactions are outlined below, with further detail provided in the relevant chapters.

9.5.3.1 Earthworks construction

The soils and geology at each earthworks area are identified in **Table 9.16**. This section relates to potential impacts associated with embankment construction and cutting excavation as discussed in **Section 9.4.2.1** and **Section 9.4.2.2** respectively.

The potential impacts of earthworks construction are listed and described below:

- Compression of Substrata
- Loss of Agricultural Land
- Loss of Solid Geology
- Loss of Future Quarry Reserves
- Introduction of Material derived from a different Lithology
- Flood Barrier
- Earthworks Haulage
- Washout of Fines / Sediment Runoff
- Effect on Surrounding Ground

Compression of Substrata

This impact applies to embankments only.

The construction of an embankment over in-situ virgin ground will cause compression of the sub-strata thus affecting the current characteristics of the ground. The magnitude of such an impact, as per **Table 9.5**, however is deemed to be insignificant due to the small footprint of the embankment areas relative to the local environment.

The significance, as per **Table 9.6** of the potential impact is imperceptible.

Loss of Agricultural Land

The construction of embankments or the excavation of cuts in areas of arable or agricultural land will result in the loss of said resource. The area lost or removed would encapsulate the width of the embankment or cut plus the footprint required for such a construction.

Refer also to **Chapter 14, Material Assets – Agricultural**.

The significance of the potential impact is moderate / slight.

Loss of Solid Geology

This impact applies to cuttings in rock only.

In accordance with the aggregate potential mapping undertaken as part of the National Development Plan 2007-2013, the study area is predominately classified as a very high aggregate potential. The construction of the proposed road development would result in the loss of the aggregate resource.

The type of bedrock that will be excavated is widely available, and as per the TII Guidelines, the portion to be removed will be small adverse in comparison to the volumes retained.

The significance of the potential impact is significant / moderate.

Loss of Future Quarry Reserves

This impact applies to Lackagh Quarry (disused quarry) and Roadstone Quarry (active quarry).

Lackagh Quarry (disused) intersects the proposed road development, impacting future quarry reserves at this location. With appropriate planning permission, the potential for future quarry reserves at Lackagh Quarry, are located beneath the disused quarry footprint and along the east and southern boundaries. Given the presence of a European designated site along the north and western boundaries of Lackagh Quarry expansion in these directions is highly unlikely. The magnitude of impact for loss of a moderate proportion of future reserves is moderate adverse.

The significance of the potential impact is moderate.

The proposed road development is located south of the active Roadstone Quarry in Twomileditch and does not directly impact the quarry. The magnitude of the impact is considered negligible, as the impact to the active quarry is of insufficient magnitude to affect the use or future quarry reserves.

The significance of the potential impact is imperceptible.

Introduction of Material derived from a different Lithology

This impact applies in granite bedrock areas.

The overburden across the study area consists of glacial till derived from the underlying bedrock. The bedrock changes in Section 2 at the N59 Moycullen Road, from a granite to a limestone bedrock which have different chemical compositions.

If limestone derived material is placed over granite bedrock, surface water run-off or groundwater movements through the material have the potential to impact local areas of peatland habitats by changing the pH of the groundwater.

This is further discussed in **Chapter 8, Biodiversity**, **Chapter 10, Hydrogeology** and **Chapter 11, Hydrology**.

The significance of the potential impact is significant / moderate.

Refer also **Chapter 7, Construction Activities**.

Flood Barrier

This impact applies to embankments only.

There are no significant encroachment of any significant floodplains. Embankment constructed in areas prone to flooding have the potential to erode, resulting in a change in the local environment and potential ground movement at the base of the embankment slope. Potential for flooding is discussed further in **Chapter 11, Hydrology**.

The significance of the potential impact is significant / moderate.

Earthworks Haulage

During earthworks construction, heavily loaded large earthmoving vehicles will travel through the site, causing ground vibrations, unwanted compaction and disturbance of natural ground of unfinished road surfaces.

See also **Chapter 7, Construction Activities**, **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration**.

The significance of the potential impact is slight.

Washout of Fines / Sediment Runoff

During or following heavy rainfall events, surface water run-off from embankments comprising of fine material (silt and clay) or exposed cuttings could have a high percentage of suspended solids and result in accumulation of unwanted material in adjacent lands.

See also **Chapter 10, Hydrogeology** and **Chapter 11, Hydrology**.

The significance of the potential impact is slight.

Effect on Surrounding Ground

Soil and rock excavation has the potential to induce movement and settlement of surrounding ground. The breaking or blasting of the bedrock could result in ground vibrations and destabilisation of existing slopes, existing rock slopes, with affects felt in the immediate vicinity of the works.

See also **Chapter 7, Construction Activities**, **Chapter 8, Biodiversity**, **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration**.

The significance of the potential impact is moderate / slight.

9.5.3.2 Re-use and processing of site material

The impacts associated with the introduction of material derived from a different lithology and earthworks haulage are applicable for the re-use and processing of site material. As mentioned in **Section 9.5.3.1** the potential impacts include:

- in the granite bedrock area, where limestone derived material is placed over granite bedrock there is potential to impact the local areas of peatland habitats by changing the pH of the groundwater. The significance of this potential impact is significant / moderate.
- ground vibrations, unwanted compaction and disturbance of natural ground of unfinished road surfaces as a result of haulage during the earthworks construction where heavily loaded large earthmoving vehicles will travel through the site. The significance of this potential impact is slight.

See also **Chapter 7, Construction Activities**, **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration**.

9.5.3.3 Importation, exportation and disposal of materials

The impacts associated with the introduction of material derived from a different lithology and earthworks haulage are applicable for the importation, exportation and disposal of materials, the impacts are mentioned above in **Section 9.5.3.2**.

See also **Chapter 7, Construction Activities**, **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration**.

9.5.3.4 Tunnelling

This section outlines the associated impacts for the construction of the mined tunnel at Coolough, Menlough (Lackagh Tunnel) and the cut and cover tunnel at Ballybrit (Galway Racecourse Tunnel).

A summary of the potential impacts for the proposed tunnel construction at each of the tunnel locations are provided below:

Potential Impact on Limestone Pavement

This potential geological impact applies to Lackagh Tunnel only.

Potential geological impacts on the integrity of the geological attribute (Limestone pavement), due to the mined tunnel, include such impacts as ground settlement, and rock mass instability. The potential geological impacts from the mining activities could include blast damage due to ground vibration and air blast vibrations. See also **Chapter 8, Biodiversity** and **Chapter 10, Hydrogeology**.

Considering the key design features presented in **Section 9.4.1** and the conservative design approach the magnitude of the potential geological impact is considered to be negligible, as the potential geological impact would result in impact on attribute but of insufficient magnitude to affect either use or integrity, as per **Table 9.5**. Further details on the proposed Lackagh Tunnel are provided in **Appendix A.7.3**.

The significance, as per **Table 9.6**, of the potential geological impact is imperceptible.

Other potential geological impacts to Limestone pavement are discussed in **Section 9.5.3.5** where Limestone pavement occurs under structures and in **Section 9.5.3.8** where it occurs within the study area.

Loss of Feature

The tunnel bores are to advance through Visean limestone, resulting in the loss of the intact rock. The cut and cover tunnel in Ballybrit will require the excavation of Visean limestone, which will also result in the loss of intact rock.

The impacts associated with the loss of solid geology are applicable for loss of feature. As mentioned in **Section 9.5.3.1** the potential impact which applies to cuttings in rock only will result in the loss of the aggregate resource. The significance of this potential impact is significant / moderate.

Ground Settlement

The impacts associated with the effects to surrounding ground are applicable for ground settlement. As mentioned in **Section 9.5.3.1** soils and rock excavations, including the breaking or blasting of the bedrock, could result in ground vibrations and destabilisation of existing slopes, existing rock slopes and has the potential to impact the surrounding ground by inducing movement. The significance of this potential impact is moderate / slight.

Potential Impact due to Blasting

The impacts associated with the effects to surrounding ground are also applicable for potential impact due to blasting and are outlined above.

Other potential construction impacts from Lackagh Tunnel and Galway Racecourse Tunnel are discussed in **Chapter 7, Construction Activities**, **Chapter 8, Biodiversity**, **Chapter 10, Hydrogeology**, **Chapter 11, Hydrology**, **Chapter 16, Air Quality and Climate**, **Chapter 17, Noise and Vibration** where the potential impacts of construction traffic, dewatering, dust and noise and vibration from blasting bedrock are described in detail.

9.5.3.5 Construction of Structures

The construction activities for structures presented in **Chapter 5, Description of Proposed Development** may impose some of the following impacts, dependant on the geology encountered at the location of the structure footings:

- Ground Settlement
- Noise and vibration
- Material disposal i.e. bored pile installation

See also **Chapter 7, Construction Activities**, **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration**.

The significance of the potential impact is slight.

Potential Impact on Limestone Pavement

Two structures along the proposed road development traverse Limestone pavement in Menlough. It should be noted, at both of these locations the Limestone pavement is outside the Lough Corrib cSAC, refer to **Chapter 8, Biodiversity** for the ecological assessment.

The proposed road development includes the construction viaduct in Menlough. The proposed Menlough Viaduct will result in the minor loss (circa 500m^2) of a small part of the attribute (Limestone pavement).

The magnitude of the potential geological impact, as per **Table 9.5** is considered small adverse, as the potential geological impact would result in loss of small part of the attribute[21].

The significance of the potential geological impact, as per **Table 9.6**, is significant / moderate.

A culvert is located in an area of Limestone pavement in Menlough. The magnitude of the potential geological impact is negligible, as the structural integrity of the Limestone pavement is maintained. The significance of the potential geological impact is imperceptible.

Other potential geological impacts to Limestone pavement are discussed in **Section 9.5.3.4** for Lackagh Tunnel and in **Section 9.5.3.8** where Limestone pavement occurs within the study area.

9.5.3.6 Contaminated Ground

No known areas of contaminated ground were located within the study area. Exposure of locations of contamination and excavation of contaminated soil may potentially lead to a risk to the surrounding environment or underlying soil if not dealt with in an appropriate manner in accordance with the Environmental Protection Agency guidance on Land Contamination.

The underlying soil could be impacted from the exposure of previous buried hazardous material, in an unlicensed dumping site for example, or from the discharge of wash water from concrete operations.

The potential impacts could also include the potential for leakage or spillage of construction related materials, contaminating the subsoils present.

For example, raw or uncured concrete and grouts, washed down water from exposed aggregate surfaces, cast-in-place concrete from concrete trucks, fuels, lubricants and hydraulic fluids for equipment used on the development site, bitumen and sealants used for waterproofing concrete surfaces can all potentially impact on soils and groundwater during construction stage.

The significance of the potential impact is moderate / slight.

9.5.3.7 Soft soil

The potential impacts associated with soft ground removal are discussed under Effects of Surrounding Ground in **Section 9.5.3.1**.

As mentioned in **Section 9.5.3.1** soil excavations could result in destabilisation of existing slopes and has the potential to impact the surrounding ground by inducing movement.

The significance of this potential impact is moderate / slight

[21] Box 5.1: Criteria for rating impact significance at EIA stage. A magnitude of impact of small adverse is one where there is a "minor impact on integrity of attribute or loss of small part of attribute" (NRA, 2009)

The potential impact associated with the presence of soft ground at structure locations is ground settlement as discussed **Section 9.5.3.5**.

9.5.3.8 Karst features

The study area contains the following karst features (which have a geological feature importance of medium or higher):

- Limestone pavement
- Turlough
- Springs

See also **Chapter 10, Hydrogeology**.

Potential Impact on Limestone Pavement

The proposed road development traverses six locations of limestone pavement in Sections 3 and 4. These locations include:

- One location at Lackagh Tunnel, which passes under an area of Limestone pavement, within Lough Corrib cSAC, refer to **Section 9.5.3.4**. The significance of this potential geological impact is imperceptible
- Two locations of Limestone pavement are under structures in Menlough, located outside Lough Corrib cSAC, refer to **Section 9.5.3.5**. The significance of this potential geological impact at these locations is considered significant / moderate and imperceptible
- Three other locations, all outside the Lough Corrib cSAC, are under the proposed road development and discussed below.

At these three locations the Limestone pavement is encapsulated under the proposed road development. Two of these locations are in Menlough and one location is in Coolagh, at these locations the proposed road development results in loss of small part of the Limestone pavement.

The significance of the potential geological impact for areas of Limestone pavement lost under the proposed road development is significant / moderate.

All other Limestone pavement areas within the study area are not directly impacted by the proposed road development.

The significance of the potential geological impact for areas of Limestone pavement within the study area but outside of the proposed road development is imperceptible.

Refer to **Chapter 8, Biodiversity** for the potential ecological impacts to Limestone pavement.

Surface Karst Solution Features

The proposed road development will result in the loss of part of the enclosed depression (K12), the enclosed depression (K97) and the spring (K193).

The significance of the potential impact for these attributes is moderate.

Additional individual karst features have been identified in the study area, as presented in
Table 9.10, however these additional ones, excluding K12, K97 and K193, will not be directly affected by the proposed road development as they exist outside the fence line.

In such situations, the significance of the potential impact is imperceptible.

9.5.4 Operational Phase

The significance rating on the soils and geology from the operational phase of the proposed road development will generally be Imperceptible according to the TII Guidelines criteria (TII, 2009). Overall there is neutral long term impact on the soils and geology along the route of the proposed road development. The potential geological impacts on the environment have been provided below for the operational phase:

Contamination

Maintenance works could lead to occasional accidental leakage of oil, petrol or diesel, allowing contamination of the surrounding environment. However, the magnitude of the impact is negligible as spills will be contained and materials will be disposed of appropriately using a fully licensed waste contractor with the appropriate permits. The significance of the potential impact is imperceptible.

Ground Movement

The mined tunnel in Coolough, Menlough, Lackagh Tunnel, may experience minimal long term ground movement (settlement) of the local environment. With the support measures as outlined in the design phase, **Section 9.4.1.1**, and monitoring during the construction phase the magnitude of the potential impact is negligible.

The significance of the potential impact is imperceptible.

9.6 Mitigation Measures

9.6.1 Introduction

This section describes the mitigation measures to reduce or avoid potential impacts where possible, for both the construction (**Section 9.5.2**) and operational phases (**Section 9.5.3**) of the proposed road development.

The mitigation measures for potential impacts to geological features are presented and summarised in **Table 9.19** for the Construction Phase and **Table 9.20** for the Operational Phase.

9.6.2 Construction Phase

The mitigation measures for the potential construction impacts are provided below.

9.6.2.1 Earthworks construction

Construction techniques that comply with the requirements of statutory bodies in terms of noise, vibration, soil and groundwater contamination and disposal of contaminated material for both soil and rock cuttings will be adopted.

Loss of Agricultural Land and Solid Geology

All excavated material, excluding a small potential volume of hazardous material, will be re-used as construction fill and material deposition areas minimising the loss of the feature. The Contractor will ensure acceptability of the material for re-use within the proposed road development with appropriate handling, processing and segregation of the material.

Introduction of Material derived from a different Lithology

A construction earthworks programme will be implemented as part of the CEMP, which is finalised by the contractor, for the proposed road development which categorises the source of material for each fill section. During the finalisation of this programme, the fill limitations outlined below will be incorporated.

To prevent impact to the local peatland habitats, described in **Chapter 8, Biodiversity**, the following fill limitations will be incorporated at the locations identified **Table 9.18**.

- Only pavement and capping layers protected from surface water runoff and groundwater movements are permitted to be derived from non-native material
- All other acceptable fill material will be derived from native material or other pH compatible material

Table 9.18: Fill Limitation Areas

Location	Annex I Habitat / Fossitt (2000) ID Codes*	Fill Limitation Chainage area	
		From	To
1	4030 mosaic	0+620	0+775
2	4010	1+300	1+450
3	4010	1+830	2+065
4	4010	2+875	3+090
5	4010	3+440	3+550
6	4030/4010 and 4010	3+595	3+890
7	4030 mosaic and 4010	4+800	5+150
8	PF2	7+850	7+900

*Refer to **Chapter 8, Biodiversity** for details

Flood Barrier

A drainage layer or starter layer, in accordance with the TII publication CC-SCD-00606, will be implemented for the construction of embankments in areas prone to flooding. The introduction of a drainage layer will ensure hydraulic conductivity exists across the flood plain and removes the risk of the embankment acting as a flood barrier.

Earthworks Haulage

Earthworks haulage will be along predetermined routes within and outside the proposed development boundary as shown on **Figures 7.101** to **7.123**.

The identified haulage routes are along existing national, regional and local routes or within the proposed development boundary.

Where compaction occurs due to truck movements and other construction activities on unfinished surfaces, remediation works will be undertaken to reinstate the ground to its original condition. Where practicable, compaction of any soil or subsoil which is to remain in-situ along the proposed road development will be avoided.

Washout of Fines / Sediment Runoff

The use of granular fill material in embankment construction will remove the likelihood of the washout of fines. However, in the event the embankment will be constructed of local material, the introduction of a drainage layer or starter layer (as discussed in Flood Barrier section above) will reduce the likelihood of run-off of fine material.

Alternatively, the introduction of a geotextile separator will reduce the potential impact in areas. A composite system, combining a drainage layer and a geotextile separator will be implemented in embankments constructed with cohesive fill material.

Sediment control methods are outlined in the CEMP in **Appendix A.7.5** and in **Chapters 10, Hydrology** and **11, Hydrogeology**.

Effect on Surrounding Ground

Ground settlement, horizontal movement and vibration monitoring will be implemented during construction activities to ensure that the construction does not exceed the design limitations.

In situations where the site specific blast design has determined that blasting is not feasible in a particular location due to excessive ground vibrations, alternative extraction methods such as hydraulic breaking, hydraulic splitting, chemical splitting and electrical disintegration may be implemented and monitored. Monitoring will be implemented during blasting, during excavation of cuts, for overburden slopes steeper than 1V:2H (V= vertical slope, H = horizontal slope) and rock slopes steeper than 1V:1.5H.

A geotechnical expert will be appointed by the contractor and will be present to monitor the surrounding ground vibrations near sensitive receptors during blasting works. In the unlikely event that the blast vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring.

Allowable distances for the various construction methods are outlined in **Chapter 17, Noise and Vibration**.

9.6.2.2 Reuse and processing of site material

A construction earthworks programme will be implemented for the proposed road development which categorises the source of material for each fill section. During the finalisation of this programme the fill limitations outlined in **Section 9.6.2.1** will be incorporated at the locations presented in **Table 9.18**.

9.6.2.3 Importation, exportation and disposal of materials

Importation of materials from outside the site will be minimised by ensuring that materials arising within the site area are used to the greatest extent possible. Any surplus material remaining which cannot be incorporated into the construction fill activities shall be placed in material deposition areas within the proposed road development. This will significantly reduce the deposition of material off-site.

Hazardous material will be transported off site for disposal or recovery at appropriately licence or permitted sites as outline in **Chapter 7, Construction Activities**.

9.6.2.4 Tunnelling

The adopted construction techniques will comply with the requirements of statutory bodies in terms of noise, vibration, soil and groundwater contamination and disposal of contaminated material.

During the construction of Lackagh Tunnel the supported rock face of Lackagh Quarry Face and retaining walls for the Western approach will be monitored for movement. A geotechnical expert will be appointed, by the contractor and will be present to monitor the rock mass stability during their construction period. In the unlikely event that instability within the rock mass is observed, additional support measures will be installed to ensure that there is no impact to the surface above. The additional rock support measures comprise ground anchors, rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures, designed to the relevant design standards and best practice guidance documents. However, based on the conservative design approach it is considered that the risk of instability will be avoided and additional support measures will not be required.

A geotechnical expert will be appointed by the contractor and will be present to monitor the vibrations at the surface, including the areas of Limestone pavement, during blasting works for the construction of Lackagh Tunnel and the Western Approach. The blast target vibration limit is defined as 20% more conservative than the conservative design approach vibration limit of 25mm/sec at the ground surface which includes areas of Limestone pavement, which provides an added factor of safety to the construction works to ensure that blasting will not impact the structural integrity of the Limestone pavement. In the unlikely event that the blast target vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring.

For further information on Lackagh Tunnel is presented in **Appendix A.7.3**.

9.6.2.5 Construction of Structures

Construction of structures will be completed in accordance with the Construction Environmental Management Plan (CEMP) in **Appendix A.7.5** and as described in the following:

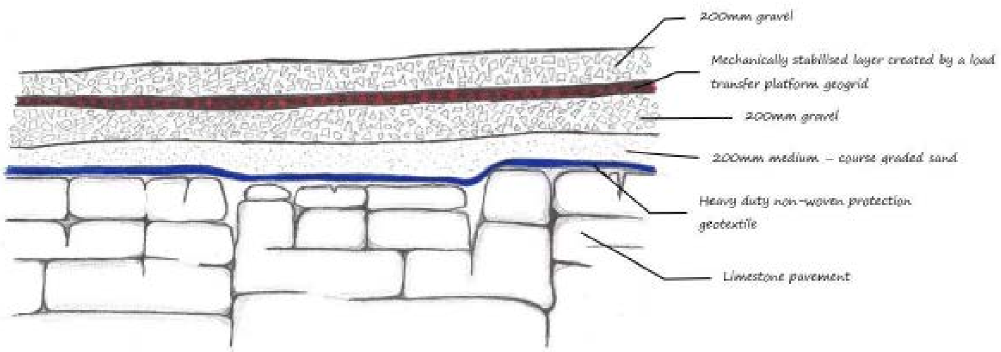
- River Corrib Bridge Constructability Examination **Appendix A.7.1**
- Menlough Viaduct Constructability Examination **Appendix A.7.2**
- Lackagh Tunnel Geotechnical and Hydrogeological Appraisal **Appendix A.7.3**
- Galway Racecourse Tunnel Constructability Report **Appendix A.7.4**

Ground settlements will be controlled through selection of the foundation type and method of construction which are suitable for the particular ground conditions.

To minimise soil movements due to pile operations in the vicinity of sensitive receptors, each pile shall be constructed sequentially in a direction away from the sensitive receptor. Previously installed piles act as a shield as soil movements are greater in a direction away from the stiffer zone i.e. away from the piles and sensitive receptors.

During construction, the Limestone pavement at Menlough Viaduct will be protected and will not be impacted by implementing a protection system comprising of geogrid, protection geotextile and layers of material, as per **Plate 9.2**. This will be removed once construction is complete. Refer to Menlough Viaduct Constructability Report in **Appendix A.7.2** for further details.

Plate 9.2: Limestone pavement protection system



9.6.2.6 Contaminated ground

No known areas of contaminated ground were located within the study area. Samples of ground suspected of contamination will be tested for contamination during the detailed investigation and ground excavated from these areas will be disposed of to a suitably licence or permitted sites in accordance with the current Irish Waste Management legislation.

Good housekeeping (daily site clean-ups, use of disposal bins, etc.) on the site, and the proper use, storage and disposal of these substances and their containers will prevent soil contamination.

For all activities involving the use of potential pollutants or hazardous materials, material such as concrete, fuels, lubricants and hydraulic fluids will be carefully handled and stored to avoid spillages. Potential pollutants shall also be adequately secured against vandalism and will be provided with proper containment according to codes of practice. Any spillages will be immediately contained and contaminated soil removed from the site and disposed of to an appropriately permitted or licenced site according to the current Irish Waste Management Legislation by the contractor.

The contractor is required to make provision for removal of any concrete wash water. Concrete trucks will be directed back to their batching plant for washout. The arrangement for concrete deliveries to the site will be discussed with suppliers before commencement of work, outlining the agreed assessed routes, prohibiting on site washout and discussing emergency procedures.

9.6.2.7 Karst features

As a minimum, the carriageway drainage network will be sealed in areas where the proposed road development crosses rock particularly prone to karstification. Through the use of engineered solutions, including an impermeable barrier, cement slurry or grout, direct run-off from the paved surface of the proposed road development will be prevented from entering into the rock along the proposed alignment, as this could cause further deterioration and instability of the rock mass. Individual mitigation measures will be assessed on a case by case basis, determined by the extent of karst and make up of the proposed road development as outlined in the karst protocol which is part of the CEMP (**Appendix A.7.5**). Inspections of karst features will be undertaken by a hydrogeologist and/or geotechnical expert in order to determine the appropriate remediation measure. These remedial measures include but are not limited to the removal of all loose, soft, weak or voided soil material, backfilling voids with an agreed combination of boulders cobbles / chunk rock / cement slurry and installation of a high strength geosynthetic to form a competent, safe foundation platform.

Mitigation measures for the protection of karst features are further outlined in **Chapter 10, Hydrogeology** and included in the Construction Environmental Management Plan (CEMP) as part of the karst protocol.

9.6.3 Operational Phase

During the operational phase, monitoring of the rock mass stability will continue. The rock and overburden retaining systems in Lackagh Quarry and Western Approach will continue to be monitored as part of the TII (Transport Infrastructure Ireland) maintenance schedule. In the extremely unlikely event that instability within the rock mass is observed additional support measures outlined above in **Sections 9.4.1.1** and **9.6.2.4**, for the construction phase will be installed to ensure that there is no impact to the structural integrity of the Limestone pavement. However, based on the conservative design approach, (the installed composite support system and monitoring during construction) it is considered that the risk of instability will be avoided and additional support measures will not be required.

Operation mitigations measures for Lackagh Tunnel are further discussed in **Appendix A.7.3**.

The implementation of the design, construction methodology control measures and mitigations measures results in no other operational phase mitigation measures for avoiding potential direct and indirect impact to the soils and geology environment for the proposed road development.

9.7 Residual Impacts

9.7.1 Construction and Operation Residual Impacts

Implementing the outlined mitigation measures will result in a number of significant residual negative impacts on the soil and geological at the construction phase. These impacts occur where the construction of the proposed road development will result in a small loss of Limestone pavement (all outside European designated sites).

Implementation of the outlined mitigation measures will result in imperceptible residual negative impacts on the soil and geological at the operation phase.

The residual impacts are shown in **Table 9.19**: Predicted Residual Impacts for Geological Features and Activities during Construction Phase and **Table 9.20**: Predicted Residual Impacts for Geological Features and Activities during Operational Phase.

Table 9.19: Predicted Residual Impacts for Geological Features and Activities during Construction Phase

Feature / Construction Activity				**Impact Assessment**				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
Limestone pavement [22]– Menlough Viaduct (outside European designated sites)	Very High	3	Menlough	Small Adverse	Results in loss of small part of attribute	Significant / Moderate	The magnitude of the loss of the attribute was minimised during the design stage where the number of piers and size of the pier footings was kept to a minimum. During construction of the viaduct, the Limestone pavement will be protected using a protection system, comprising of geogrid, protection geotextile and layers of material. This will be removed once construction is complete.	Significant / Moderate

[22] This table presents the geological assessment of Limestone pavement, refer to **Chapter 8, Biodiversity** for an ecological assessment.

Feature / Construction Activity				Impact Assessment				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
Limestone pavement – Covered by the proposed road development (outside European designated sites)	Very High	3 and 4	Menlough and Coolagh	Small Adverse	Results in loss of small part of attribute	Significant / Moderate	No mitigation available	Significant / Moderate
Limestone pavement – Lackagh Tunnel (within European designated sites)	Very High	3	Coolagh	Negligible	Results in an impact on attribute but of insufficient magnitude to affect integrity	Imperceptible	The engineered design solutions to reduce the impact of the integrity of the geological feature will be monitored on site during construction. These solutions include sufficient rock above the tunnel bores, a suitable pillar between the bores to protect the tunnel from collapse and suitable blasting sequences. The site control measures include probing ahead of the tunnel and	Imperceptible

Feature / Construction Activity				**Impact Assessment**				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
							mapping of the tunnel blast face and monitoring of the blast. Where required the introduction of stability measures will be implemented including rock bolts, and a robust steel tunnel lining.	
Limestone pavement – All other areas (Both within and outside European designated sites)	Very High	3 and 4	Menlough to Castlegar	Negligible	Results in an impact on attribute but of insufficient magnitude to affect integrity	Imperceptible	Not required	None
Palaeokarst	Medium	2, 3 and 4	Menlough, Ballindooley, Castlegar	Small Adverse	Proposed construction will result in the loss of small part of the attribute	Slight	No mitigation available	Slight
Karst: K7 - Spring	Medium	2	Bushypark	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K10 – Enclosed Depression	Medium	2	Bushypark	Negligible	No measurable change to attribute	Imperceptible	Not required	None

Feature / Construction Activity				Impact Assessment				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
Karst: K11 – Enclosed Depression	Medium	2	Bushypark	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K12 – Enclosed Depression	Medium	2	Bushypark	Moderate Adverse	Proposed construction will result in the loss of part of the attribute	Moderate	No mitigation available	Moderate
Karst: K17 - Spring	Medium	3	Menlough	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K25 - Spring	Medium	3	Menlough	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K31 - Turlough	Medium	3	Menlough	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K44 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K45 - Spring	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K49 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None

Feature / Construction Activity				Impact Assessment				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
Karst: K51 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K54 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K57 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K59 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K61 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K62 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K64 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K67 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K70 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None

Feature / Construction Activity				Impact Assessment				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
Karst: K71 - Enclosed Depression	Medium	3	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K97 - Enclosed Depression	Medium	3	Castlegar	Moderate Adverse	Proposed construction will result in the loss of part of the attribute	Moderate	No mitigation available	Moderate
Karst: K104 - Enclosed Depression	Medium	3	Castlegar	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K131 - Enclosed Depression	Medium	3	Parkmore	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K158 - Spring	Medium	4	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K161 - Spring	Medium	4	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K172 - Enclosed Depression	Medium	4	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K175 - Enclosed Depression	Medium	4	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None

Feature / Construction Activity				Impact Assessment				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
Karst: K176 - Spring	Medium	4	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K179 - Enclosed Depression	Medium	4	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K181 - Spring	Medium	4	Coolagh	Negligible	No measurable change to attribute	Imperceptible	Not required	None
Karst: K193 - Spring	Medium	4	Coolagh	Moderate Adverse	Proposed construction will result in the loss of part of the attribute	Moderate	No mitigation available	Moderate
Geological Heritage Site (GHA06): Igneous Intrusions	Very High	1	Bearna	Negligible	Feature is located within study area but will undergo no measurable change during construction	Imperceptible	Not required	-
Geological Heritage Site (GHA01): Roadstone Quarry	Very High	3	Twomileditch	Negligible	Feature is located within study area but will undergo no measurable change during construction	Imperceptible	Not required	-
Agricultural Soil AminDW:	High	1 and 2	Widespread across western portion of study area	Small Adverse	Irreversible loss of small proportion of	Moderate / Slight	All excavated agricultural soil shall be used as	Moderate / Slight

Feature / Construction Activity				Impact Assessment				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
Deep well drained non-calcareous soil					local high fertility soils and / or high proportion of local low fertility soils		construction fill or placed in deposition areas and will contribute to the construction material requirements for the proposed road development.	
Agricultural Soil AminSW: Shallow well drained non-calcareous soil	High	1 and 2	Widespread across western portion of study area	Small Adverse	Irreversible loss of small proportion of local high fertility soils and / or high proportion of local low fertility soils	Moderate / Slight	All excavated agricultural soil shall be used as construction fill or placed in deposition areas and will contribute to the construction material requirements for the proposed road development.	Moderate / Slight
Agricultural Soil BminDW: Deep well drained calcareous soil	High	2, 3 and 4	Widespread across eastern portion of study area	Small Adverse	Irreversible loss of small proportion of local high fertility soils and / or high proportion of local low fertility soils	Moderate / Slight	All excavated agricultural soil shall be used as construction fill or placed in deposition areas and will contribute to the construction material requirements for	Moderate / Slight

Feature / Construction Activity				**Impact Assessment**				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
							the proposed road development.	
Agricultural Soil BminSW: Shallow well drained calcareous soil	High	2, 3 and 4	Widespread across eastern portion of study area	Small Adverse	Irreversible loss of small proportion of local high fertility soils and / or high proportion of local low fertility soils	Moderate / Slight	All excavated agricultural soil shall be used as construction fill or placed in deposition areas and will contribute to the construction material requirements for the proposed road development.	Moderate / Slight
Quarry Q01: Lackagh Quarry - Disused	Medium	3	Lackagh / Coolagh	Moderate Adverse	Loss of moderate portion of future quarry or pit reserves	Moderate	No mitigation available	Moderate
Quarry Q02: Roadstone Quarry	Very High	3	Twomileditch	Negligible	The proposed road development is located south of Roadstone Quarry. Impact to the active quarry is of insufficient magnitude to affect the use or	Imperceptible	Not available	-

Feature / Construction Activity				Impact Assessment				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
					future quarry reserves.			
Mineral ML23: Roadstone Dimension Stone	Very High	3	Twomileditch	Negligible	Feature is located within study area but will undergo no measurable change during construction	Imperceptible	Not required	-
Mineral ML24: Roadstone Limestone (in general)	Very High	3	Twomileditch	Negligible	Feature is located within study area but will undergo no measurable change during construction	Imperceptible	Not required	-
Crushed Rock Aggregate Potential: Very High Potential	Very High	1, 2, 3 and 4	Entire Study Area	Small Adverse	Loss of small proportion of future quarry or pit reserves or potential aggregate	Significant / Moderate	All excavated crushed rock shall be used as construction fill or placed in deposition areas and will contribute to the construction material requirements for the proposed road development.	Moderate / Slight
Crushed Rock Aggregate	High	1, 2 and 3	Na Foraí Maola,	Negligible	No measurable change to attribute	Imperceptible	Not required	-

Feature / Construction Activity				Impact Assessment				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
Potential: High Potential			An Chloch Scoilte, Rahoon, Letteragh, Dangan					
Crushed Rock Aggregate Potential: Moderate Potential	Medium	1 and 2	An Chloch Scoilte, Dangan	Negligible	No measurable change to attribute	Imperceptible	Not required	-
Sub-Embankment Compression: Compression of founding material on the underside of the embankment	Medium	1, 2, 3 and 4	All fill areas	Negligible	Results in an impact on attribute but of insufficient magnitude to affect integrity	Imperceptible	Not required	-
Introduction of Material derived from a different Lithology	High	1, 2, 3 and 4	All fill areas	Moderate Adverse	Results in impact on integrity of attribute	Significant / Moderate	Detailed construction earthworks programme outlining use of all cut material, haulage routes, plans and continuous monitoring of earthwork movement. Limitations will be implemented in eight locations in the granite region. The restrictions in	Imperceptible

Feature / Construction Activity				**Impact Assessment**				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
							these locations are only pavement and capping layers protected from surface water runoff and groundwater movements are permitted to be derived from non-native material and all other acceptable fill material will be derived from native material or other pH compatible material	
Embankment Flood Barrier: Blockade of water due to embankment	High	-	All fill areas in floodplains	Moderate Adverse	Results in impact on integrity of attribute	Significant / Moderate	Introduction of a drainage / starter layer within the embankment makeup to provide hydraulic conductivity.	Moderate / Slight
Haulage of Material: Unwanted compaction or disturbance	Medium	1, 2, 3 and 4	Widespread	Small Adverse	Results in minor impact on integrity of attribute	Slight	No mitigation available	Slight

Feature / Construction Activity				Impact Assessment				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
Washout of Fines: Risk of deposition of sediment on agricultural land	Medium	1, 2, 3 and 4	Widespread	Small Adverse	Results in minor impact on integrity of attribute	Slight	In embankments, drainage layers incorporating geotextile separators will be utilised. The use of granular fill will also remove the risk of washout of fines	Imperceptible
Settlement, Movement from Cutting	High	1, 3 and 4	All cut areas	Small Adverse	Results in impact on integrity of attribute	Moderate / Slight	Ground settlement and vibration monitoring during excavation activities will be implemented to ensure that the works do not exceed the design limitations. Where blasting is not viable, alternative methods of rock fracturing such as hydraulic breaking shall be implemented. This will result in protection to attributes but an	Moderate / Slight

Feature / Construction Activity				**Impact Assessment**				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
							extended construction timeline.	
<u>Foundation Construction:</u> Ground settlement, noise and vibration caused from foundation construction	Medium	1, 2, 3 and 4	Widespread	Small Adverse	Results in loss of small part of attribute and integrity of attribute	Slight	No mitigation available	Slight
<u>Construction Contamination:</u> Chemical spillage, material accumulation, or concrete activities	High	1, 2, 3 and 4	Widespread	Small Adverse	Results in minor impact on integrity of attribute and requirement to excavate waste material	Moderate / Slight	A requirement is to be introduced where all contaminants are carefully handled and stored to avoid spillages. Potential pollutants will be adequately secured against vandalism and should be provided proper containment according to code of practice.	Imperceptible

Table 9.20: Predicted Residual Impacts for Geological Features and Activities during Operational Phase

Feature / Operational Activity				Impact Assessment				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Risk**
Limestone pavement – Menlough Viaduct	Very High	3	Menlough	Negligible	Results in impact on attribute but of insufficient magnitude	Imperceptible	Continuous monitoring should be conducted in sensitive zones.	Imperceptible
Limestone pavement - Menlough	Very High	3	Menlough	Negligible	Results in impact on attribute but of insufficient magnitude	Imperceptible	No mitigation available	Imperceptible
Limestone pavement – Lackagh Tunnel	Very High	3	Coolagh	Negligible	Results in impact on attribute but of insufficient magnitude	Imperceptible	No mitigation available	Imperceptible
Limestone pavement – All other areas	Very High	3 and 4	Menlough to Castlegar	Negligible	Results in impact on attribute but of insufficient magnitude	Imperceptible	No mitigation available	Imperceptible
Geological Heritage Site: Igneous Intrusions	Very High	1	Bearna	Negligible	No measurable change to the attribute	Imperceptible	Not required	-
Geological Heritage Site: Roadstone Quarry	Very High	3	Twomileditch	Negligible	No measurable change to the attribute	Imperceptible	Not required	-
Agricultural Soil AminDW: Deep well drained non-calcareous soil	High	1 and 2	Widespread across western portion of study area	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible	No mitigation available	Imperceptible
Agricultural Soil AminSW: Shallow well	High	1 and 2	Widespread across western	Negligible	Results in an impact on attribute but of insufficient magnitude	Imperceptible	No mitigation available	Imperceptible

Feature / Operational Activity				**Impact Assessment**				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Risk**
drained non-calcareous soil			portion of study area		to affect either use or integrity			
Agricultural Soil BminDW: Deep well drained calcareous soil	High	2, 3 and 4	Widespread across eastern portion of study area	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible	No mitigation available	Imperceptible
Agricultural Soil BminSW: Shallow well drained calcareous soil	High	2, 3 and 4	Widespread across eastern portion of study area	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible	No mitigation available	Imperceptible
Quarry Q02: Roadstone Quarry	Very High	3	Twomileditch	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible	No mitigation available	Imperceptible
Mineral ML23: Roadstone Dimension Stone	Very High	3	Twomileditch	Negligible	No measurable change to the attribute	Imperceptible	Not required	-
Mineral ML24: Roadstone Limestone (in general)	Very High	3	Twomileditch	Negligible	No measurable change to the attribute	Imperceptible	Not required	-
Crushed Rock Aggregate Potential: Very High Potential	Very High	1, 2, 3 and 4	Entire Study Area	Negligible	No measurable change to the attribute	Imperceptible	Not required	-

Feature / Operational Activity				**Impact Assessment**				
Name	**Importance**	**Assessment Section**	**Location**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Risk**
Crushed Rock Aggregate Potential: High Potential	High	1, 2 and 3	Na Foraí Maola, An Chloch Scoilte, Rahoon, Letteragh, Dangan	Negligible	No measurable change to the attribute	Imperceptible	Not required	-
Crushed Rock Aggregate Potential: Moderate Potential	Medium	1 and 2	An Chloch Scoilte, Dangan	Negligible	No measurable change to the attribute	Imperceptible	Not required	-
Maintenance Works - Contamination: Contamination possible from machinery used	High	1, 2, 3 and 4	Widespread	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible	No mitigation available	Imperceptible
Maintenance Works - Trafficking: Settlement, disturbance due to trafficking	High	1, 2, 3 and 4	Widespread	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible	No mitigation available	Imperceptible
Rock Stability: Stability of quarry face	Very High	3	Coolagh	Negligible	No measurable change to the attribute	Imperceptible	Continuous monitoring should be conducted in sensitive zones.	Imperceptible
Long term Ground Movements: Ground movement, settlement due to tunnel construction	High	3 and 4	Menlough, Ballybrit	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible	Continuous monitoring should be conducted in sensitive zones.	Imperceptible

9.7.2 Cumulative Impacts

The cumulative residual construction and operational impacts of the proposed road development and the following projects and plans have been assessed:

- The N59 Oughterard to Maam Cross
- M17 / N18 Gort to Tuam PPP Scheme
- Galway Harbour Port Extension
- Galway Transport Strategy (GTS), which includes the following:
  - Investigate prospective sites to the east of the city for Park and Ride
  - Bearna Greenway
  - Tuam Road Bus Corridor Scheme
  - Expansion of Public Bike Hire Scheme
- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021

Cumulative soils and geology impacts can occur when other projects in the locality have similar soils and geology potential impacts as the proposed road development. Cumulative impacts are assessed based on the residual impact[23] of these impacts on the proposed projects.

The following feature / construction activity impacts are identified in the projects and plans, listed above, and are also present in the proposed road development:

- Peat Removal / Disposal
- Impact to Geological Heritage Sites
- Contaminated Ground
- Loss of agricultural land and solid geology
- Haulage of material

As part of the environmental evaluation of the proposed road development the residual impact from peat removal/disposal, of geological heritage sites and contaminated ground is imperceptible. Due to the mitigation measures considered in the other project, the residual impact of those projects is also considered imperceptible. Therefore, the cumulative impact of these impacts is imperceptible.

The cumulative impact for:

- peat removal /disposal is considered to be imperceptible as peat is intended to remain within the proposed development boundary for each respective project
- geological heritage sites is considered to be imperceptible as none of the projects indicate that a geological heritage sites or county geological sites will

[23] This infers that mitigation measures have been implemented and the cumulative impact is assessed against the residual risk.

be impacted. The Galway Transport Strategy specifically outlines that it will seek to protect such sites from any inappropriate measures

- contaminated ground is considered to be imperceptible as the Galway City Development Plan (2017-23) waste management policy contains policy to ensure that proposals on contaminated lands include appropriate remediation measures

Loss of agricultural land and solid geology and haulage of material, whether imported or sourced from site, are activities that are also considered on other projects. Mitigation measures for other projects include the reduction and minimisation of removal or disposal of material off-site and the reuse of such material whether in construction fill or in designated material deposition areas. Consideration has been given to the extent of material which will be imported, exported or disposed and their combined impact. The cumulative impact is considered to remain unchanged as the combination of the impact will not increase the magnitude of the impact from small adverse.

The significance of the impact of the proposed road development operational activities is imperceptible and is considered not to change in combination with the other projects.

Therefore, there are no other plans or projects that are likely to result in a significant effect on soils and geology cumulatively with the proposed road development.

9.7.3 Residual Impacts Summary

The construction and operational residual impacts for the proposed road development are presented in **Table 9.19** and **9.20** respectively. After consideration of the other projects in the locality, the cumulative residual impact for the construction and operational stage is as per **Table 9.19** and **9.20** for the proposed road development and there are no cumulative soils and geology impacts.

9.8 Summary

The soils and geology environment will be impacted by the proposed road development.

Certain geological features will be impacted in all earthwork sections and these are highlighted in **Section 9.8.1**, loss of attributes.

Potential impacts due to construction or operational activities have the potential to occur, but the significance of the impact will be reduced, where possible, with implementation of mitigation measures. The potential residual impacts are presented in **Section 9.8.2** and **Section 9.8.3** respectively.

A summary review of the four sections of the proposed road development is presented in **Section 9.8.4** to **Section 9.8.7**.

Construction will be completed in accordance with the Construction Environmental Management Plan in **Appendix A.7.5**.

9.8.1 Loss of Attributes

A proportion of well drained fertile soil and crushed rock aggregate potential will be lost within the footprint of the proposed road development. The significance of such a loss is considered a moderate / slight impact in the case of agricultural soil and significant / moderate in the case of the crushed rock aggregate potential. While no mitigation measure can be implemented to reduce the impact on the agricultural soil, all excavated material will be used as construction fill or placed in deposition areas, thus contributing to the construction material requirements for the proposed road development. The re-use of the crushed rock aggregate potential is considered to be a reduction in impact to future quarry reserves, thus reducing the impact to a residual impact of moderate / slight.

The loss of part of three karst features will result from the proposed road development, enclosed depression (K12), enclosed depression (K97) and spring (K193). The significance of the potential impact for these attributes is moderate.

The proposed road development traverses locations of Limestone pavement in Sections 3 and 4 that is located both within and outside European designated sites. The geological assessment (importance and impact) has not differentiated between Limestone pavement located within or outside the European designated sites. Refer to **Chapter 8, Biodiversity** for an ecological assessment of Limestone pavement.

Lackagh Tunnel passes under an area of Limestone pavement that is within a European designated site resulting in minimal to no impact on the feature from a geological perspective. Menlough Viaduct and a culvert in Menlough pass over Limestone pavement (both outside European designated sites), resulting in a loss of a small part of the attribute under the viaduct piers and no impact on the feature under the culvert. There are three locations where the proposed road development traverses and covers Limestone pavement (all outside European designated sites): two locations in Menlough and one location in Coolagh. At these locations it will result in loss of a small part of the Limestone pavement, it should be noted that both of these locations are outside of the European designated sites.

The geological significance of loss of Limestone pavement was assessed at each location with the results ranging from imperceptible where there is no impact to significant/ moderate where loss of small part of the attribute occurs.

The proposed road development will result in the loss of part of the palaeolandscape in the east of the city. These features are known to be located in Menlough, Ballindooley and Castlegar. The significance of the loss of these features is slight.

The proposed road development will also result in the moderate loss of future reserves, with appropriate planning, at Lackagh Quarry (disused quarry). The significance of the loss of future reserves is considered moderate.

9.8.2 Residual Impacts due to Construction

Introduction of material derived from a different lithology, washout of fines, spread of contamination, construction induced flooding or unwanted disturbance of environment are all potential construction impacts on the receiving environment. Development and implementation of mitigation measures reduce such impacts to a moderate / slight or imperceptible residual impact on the soils and geology environment.

9.8.3 Residual Impacts due to Operation

All operational activities of the proposed road development are deemed to produce imperceptible impacts to the surrounding geological environment.

9.8.4 Section 1: Chainage 0+000 to 8+500 (R336 to the N59 Moycullen Road)

Section 1 contains the least number of potential impacts out of all four sections. All unique impacts applicable to Section 1 are presented in this section.

Settlement or movement of the surrounding environment can be induced adjacent to large cuttings, such as in Ballard or Letteragh. A clear understanding of the soil /rock behaviour, following detailed ground investigation, will contribute to the development of the detailed design and construction methodology in order to reduce or completely remove construction induced movement.

Blasting will be required for deep cuttings in rock, such as the characteristics anticipated for the cut sections in Ballard and Letteragh. Data obtained from trial blasts will calibrate the blast design to site specific designs and will refine the blast design properties. Where blasting is not viable, rock breaking will be conducted by hydraulic breaking/splitting or other industry methods.

In this granite region to prevent impact to the local peatland habitats**,** the following fill limitations will be incorporated at the locations identified **Table 9.18** of this chapter.

- Only pavement and capping layers protected from surface water runoff and groundwater movements are permitted to be derived from non-native material
- All other acceptable fill material will be derived from native material or other pH compatible material

This will be included in the construction earthworks programme which categorises the source of material for each fill section.

9.8.5 Section 2: Chainage 8+500 to 9+400 (N59 Moycullen Road to the River Corrib)

Section 2 is completely in fill and contains the second least number of potential impacts of all sections. The section is also the shortest length at only 900m. All unique impacts applicable to Section 2 are presented in this section.

The bedrock changes from granite to limestone in Section 2 at the N59 Moycullen Road, with the overlying materials having different chemical compositions. As such at the locations identified in **Table 9.18** in the granite region the following fill limitations will be incorporated:

- Only pavement and capping layers protected from surface water runoff and groundwater movements are permitted to be derived from non-native material
- All other acceptable fill material will be derived from native material or other pH compatible material

River Corrib Bridge will require a specialised foundation solution due to the soft ground anticipated and karst risk in the area. The foundation solution will require the installation of piles which could induce ground settlement in the surrounding environment and cause noise and vibrations from the installation works.

9.8.6 Section 3: Chainage 9+400 to 14+000 (River Corrib to the N83 Tuam Road)

Section 3 contains the largest number of impacts out of all four sections. All unique impacts applicable to Section 3 are presented in this section.

Sixteen structures located in Section 3 will potentially require specialised foundation solutions. The location and name of these structures are presented in **Table 9.17**. Two of the structures are located on the boundary between Section 3 and 4.

The proposed road development traverses locations of Limestone pavement located within and outside European designated sites in Sections 3. These locations are:

- Menlough Viaduct and a culvert structure traverse over areas of Limestone pavement both outside European designated sites resulting in loss of a small part of Limestone pavement at the viaduct
- There are two other locations in Menlough which will result in loss of part of the Limestone pavement that is located outside European designated sites through encapsulation
- Lackagh Tunnel traverses beneath Limestone pavement that is located within European designated sites and will emerge into Lackagh Quarry. A conservative design approach has been adopted for Lackagh Tunnel including ground anchors, rock bolts, rock dowels, steel mesh and shotcrete controlling rock stability and tunnel design features. As an additional control measure, a geotechnical expert will be appointed to monitor the rock mass stability at construction and operation stages. In the extremely unlikely event, due to the adopted conservative design approach, that instability within the rock mass is observed additional support measures such as ground anchors, rock bolts, rock dowels will be installed to ensure that there is no impact to the Limestone pavement. Based on the conservative design approach, it is considered that the risk of instability will be avoided and additional support measures will not be required. The residual risk is considered imperceptible to the Limestone pavement. Further details in relation to this can be found in **Appendix A.7.3**.

The remaining structures in **Table 9.17** are likely to require a robust foundation solution due to soft ground or karst which is present throughout section 3. The foundation solutions will require either the installation of piles or an excavation and replace of soft ground, which could induce ground settlement in the surrounding environment and cause noise and vibrations from the works.

Settlement or movement of the surrounding environment can be induced adjacent to large cuttings. The implemented design and selected construction methodology, will reduce or completely remove construction induced movement.

Blasting will be required for the tunnel construction and for deep cuttings in rock. Blasting may not be viable at all locations as a result of the local receptors limitations. Where blasting is not viable, alternative rock breaking methods will be implemented such as hydraulic breaking/splitting or other industry methods. As part of the blast design assessment monitored trial blasts in the same bedrock formation as the proposed blast locations at locations of proposed blasting will be conducted. These trial blasts will calibrate the blast design to site specific designs and will refine the blast design properties. Trial blasts will not exceed the limitations of the local sensitive receptors.

The proposed road development intersects a disused Lackagh Quarry and is located south of an active Roadstone Quarry in Twomileditch. Considering the proposed road development, the quarry location, proximity and status the potential impact of future reserves was assessed. The proposed road development will result in the loss of moderate proportion of future quarry reserves at Lackagh Quarry. The magnitude of such an impact is considered moderate adverse. No mitigation measure can be implemented to reduce this impact. The significance of the impact is moderate for the disused Lackagh Quarry. At Roadstone Quarry the proposed road development does not directly impact the quarry. The magnitude of the impact is considered negligible, as the impact to the active quarry is of insufficient magnitude to affect the use or future quarry reserves. The significance of the potential impact is imperceptible for the active Roadstone Quarry.

9.8.7 Section 4: Chainage 14+000 to 17+500 (N83 Tuam Road to the existing N6 at Ardaun, Coolagh)

All unique impacts applicable to Section 4 are presented in this section.

Two structures in Section 4 will potentially require specialised foundation solutions. The location and name of these structures are presented in **Table 9.17**. The foundation solution may require the installation of piles, which could induce ground settlement in the surrounding environment and cause noise and vibrations from the piling works.

Settlement or movement of the surrounding environment can be induced adjacent to large cuttings. The implemented design and selected construction methodology, will reduce or completely remove construction induced movement. Tolerances will be set for cuttings adjacent to properties.

The proposed road development traverses one location of Limestone pavement, which is located outside the European designated sites, in Sections 4 in Coolagh resulting in the loss of small part of the Limestone pavement.

Blasting will be required for the construction of the Galway Racecourse cut and cover tunnel. As part of the blast design data obtained from trial blasts will calibrate the blast design to site specific designs and will refine and validate the blast design properties. Where blasting is not viable, rock breaking will be conducted by hydraulic breaking/splitting or other industry methods.

9.9 References

Department of Communications, Climate Action and Environment. (2016) *Natural Resources Data Downloads* [online] Available at: http://www.dccae.gov.ie/natural-resources/en-ie/Geological-Survey-of-Ireland/Pages/Data-Downloads.aspx# [Accessed 14/06/2016]

Environmental Protection Agency. (2016) *Data Download Portal* [online] Available at: http://gis.epa.ie/GetData/Download [Accessed 14/06/2016]

Teagasc. (2016) *Data and Downloads* [online] Available at: http://gis.teagasc.ie/soils/downloads.php [Accessed 14/06/2016]

EPA. Environmental Protection Agency. (2002 and Draft, September 2015) *Revised Guidelines on the Information to be contained in Environmental Impact Statements*.

EPA. (2003 and Draft, September 2015) *Advice Notes For Preparing Environmental Impact Statements.*

EPA. (Draft, May 2017) *Guidelines on the information to be contained in environmental impact assessment reports.*

10 Hydrogeology

10.1 Introduction

This chapter of the EIAR consists of an appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, under the heading of hydrogeology.

This chapter initially sets out the methodology followed (**Section 10.2**), describes the receiving environment (**Section 10.3**) and summarises the main characteristics of the proposed road development which are of relevance for hydrogeology (**Section 10.4**). The evaluation of impacts of the proposed road development on hydrogeology are described (**Section 10.5**) and measures are proposed to mitigate these impacts (**Section 10.6**). The residual impacts are also described (**Section 10.7**). The chapter concludes with a summary (**Section 10.8**) and reference section (**Section 10.9**).

This chapter has utilised the information gathered during the constraints and route selection phases of the proposed road development to inform the hydrogeology impact appraisal. **Sections 4.5**, **6.5.3** and **7.6.3** of the **Route Selection Report** considered the hydrogeology constraints within the proposed road development study area and compared the potential hydrogeology impacts of the proposed route options respectively. These sections of the **Route Selection Report** contributed to the design of the proposed road development which this chapter appraises.

10.2 Methodology

10.2.1 Introduction

This section outlines the methodology used to prepare this chapter of the EIAR and is founded on current legislation and guidelines.

10.2.2 Legislation and Guidelines

This chapter is prepared having regard to the requirements of Section 50 Sub-section (2 and 3) of the Road Act 1993 as amended, and with the following guidance:

- Environmental Protection Agency (EPA) Guidelines on Information to be contained in Environmental Impact Statements (EPA, 2002)
- Environmental Protection Agency (EPA) Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA, 2003)
- Transport Infrastructure Ireland (TII) Environmental Impact Assessment of National Road Schemes – A Practical Guide (NRA, 2008)

- Transport Infrastructure Ireland (TII) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA, 2009)
- Institute of Geologists of Ireland (IGI) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (IGI, 2013)
- Environmental Protection Agency (EPA) Draft Revised Guidelines on Information to be contained in Environmental Impact Statements (EPA, 2015)
- Environmental Protection Agency (EPA) Draft Advice Notes for Preparing Environmental Impact Statements (EPA, 2015)
- Transport Infrastructure Ireland (2015) Design Manual for Roads and Bridges
- Guidelines on the Information to be contained in Environmental Impact Assessment Reports (Environmental Protection Agency, Draft May 2017)

The main guidelines used in preparing this chapter are the EPA Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA, 2002, 2015 and 2017) and the most recent publication by the TII which outlines the assessment methodology for Soils, Geology and Hydrogeology for National Road Schemes (NRA, 2009). The latter guidelines are referred to as TII Guidelines within this chapter.

Water resource management in Ireland is dealt with in the following key pieces of legislation:

- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy
- Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration
- European Communities (Water Policy) Regulations 2014 (S.I. No 350 of 2014)
- European Communities (Water Policy) Regulations 2014 (S.I. No. 350 of 2014)
- European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010), as amended
- European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I. No. 272 of 2009) as amended
- European Union (Drinking Water) Regulations 2014 (S.I. No. 122/2014)
- European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. No. 293/1988)
- Water Services Acts 2007 to 2014

10.2.3 Consultations

Consultation was carried out with relevant bodies to identify any hydrogeological features which may be impacted by the proposed road development. Consultation was undertaken by the design team with additional consultation undertaken by the project hydrogeologists with hydrogeology specialists in the Geological Survey of Ireland, Environmental Protection Agency and the National Federation of Groundwater Schemes.

Those consultations relevant to the hydrogeology impact assessment are:

- Geological Survey of Ireland (GSI) (Department of Communications, Climate Action and Environment (DoCCAE)) Groundwater Division
- Local Area engineers in Galway County Council and Galway City Council. The Water Services Section confirmed the location of the nearest public supply schemes
- National Parks and Wildlife Services (NPWS) part of the Department of Culture, Heritage and the Gaeltacht (DCHG)
- Landowners within the study area potentially affected by the proposed road development
- Environmental Protection Agency (EPA) – EPA was consulted to determine the location of any waste licence or groundwater monitoring locations within the study area. There are no EPA monitoring sites within the proposed development boundary of the proposed road development. There are a number of EPA monitoring sites on the River Corrib as outlined in **Chapter 11, Hydrology**
- Teagasc
- Office of Public Works (OPW)
- National Federation of Group Water Schemes (NFGWS)

Consultation was also undertaken with other environmental experts on the project team in order to assess the potential impact of the interaction with other environmental factors. This included discussions on the following:

- Biodiversity – Consultation on the potential impact on groundwater dependant habitats
- Soils and Geology – Consultation on geotechnical and contaminated land issues
- Hydrology – Consultation on the potential impact on surface water systems
- Drainage – Consultation on design of runoff and groundwater management
- Material Assets – Consultation on the impact on private wells

10.2.4 Study Area

In accordance with the TII Guidelines, the area of hydrogeological study should include all features which may be impacted from the proposed road development. The study area extent is dependent on the hydrogeological characteristics of the bedrock aquifer that the proposed road development traverses e.g. the potential study area for a poor aquifer will be significantly smaller than the study area for a regionally important karst aquifer.

Based upon the screening undertaken at route selection stage the extent of the study area was conservatively taken as being 250m from the proposed development boundary for the western section of the proposed road development (west of the N59 Moycullen Road), where the aquifer is classified as being poorly productive.

The eastern section of the proposed road development (east of the N59 Moycullen Road) includes regionally important karstified aquifers and the extent of the study area was taken as the extent of the groundwater catchments, or sub-catchments as appropriate, that the proposed road development traverses.

Groundwater catchments, referred to as groundwater bodies (GWB) have been mapped by the Geological Survey of Ireland (GSI). The boundaries for these groundwater divides have been refined as part of this assessment to provide a full assessment of all receptors that have the potential to be impacted by the proposed road development.

For some GWB, the project data demonstrates that parts of the GWB are hydrogeologically separate from the rest of the GWB and this has allowed sub-catchments for some of the GSI GWB to be defined. The refined GWB and identification of sub-catchments are presented in the conceptual model in **Section 10.3.3** and the implications for the impact assessment are discussed in **Section 10.3.4** and **Section 10.4**.

10.2.5 Data Sources and Baseline Data Collection

The existing baseline ground conditions within the study area of the proposed road development have been interpreted from desk studies, field studies and commissioned ground investigations. The data sources for each of these are described below.

10.2.5.1 Desk Study

The following sources of information were reviewed in order to evaluate the hydrogeology of the proposed road development:

- Current and historical Ordnance Survey maps available for the study area (1:2,500 and 1:10,560 scales)
- Aerial photography (2012) of the study area
- Aerial imagery from Google (imagery from 2003 to 2017) and Bing accessed in 2017
- Geological and hydrogeological maps of the site area produced by the Geological Survey of Ireland (GSI) (www.dcenr.gov.ie, accessed 2017)
- MacDermot, C.V., McConnell, B. and Pracht, M. (2003) *Geology of Galway Bay 1:100,000 scale Bedrock Geology Map Series*, Sheet 14, Galway Bay, Geological Survey of Ireland

- Pracht, M. and Somerville I.D., 2015. A Revised Mississippian lithostratigraphy of County Galway (western Ireland) with analyses of Carbonate lithofacies, biostratigraphy, depositional environments and paleogeography reconstructions utilising new borehole data. Journal of paleogeography. Volume 4, Issue 1, January 2015, Pages 1-26
- Teagasc and the Environmental Protection Agency Irish Soil Information System (http://gis.teagasc.ie/soils/index.php, accessed 2017
- Ground investigation reports held by the Geological Survey of Ireland for the study area (ref **Appendix A.9.1.1**)
- Flood, P. and Eising, J. (1987). *The use of vertical band drains in the construction of the Galway Eastern Approach Road*. Proceedings of the 9th European Conference on Soil Mechanics and Foundation Engineering, Dublin, Ireland
- Lidar elevation data commissioned by OPW
- N6 Galway City Outer Bypass Scheme (2006 GCOB):
  - Galway City Outer Bypass R336 Western Approach Constraints Study Report 2000
  - N6 Galway City Outer Bypass Constraints Study Report (2000)
  - Galway County Council Galway City Outer Bypass Preliminary Ground Investigation, 2006
  - N6 Galway City Outer Bypass Environmental Impact Statement (2006)
- Data available from the Geological Survey of Ireland:
  - R1340 Galway County Council Eastern Approach Road Galway (N6) (Ballybane – Doughiska), 1993
  - R1365 Thos. Garland and Partners Digital Limited, Galway Industrial Estate, 1983
  - R3176 Dermot Rooney and Associates I.D.A Business Park, Daingean, Galway, 1997
  - R5906 Irish Linen Proposed Irish Linen Factory, Rahoon, Galway, 2005
  - R6136 Galway County Council Residential Development, Headford Road, Galway, 2006
  - R6898 Storm Technology Office Block Development, Daingean, Galway, 2006

10.2.5.2 Field Studies

As part of the environmental studies a number of surveys and walkovers were undertaken to assess the hydrogeological environment. These can be summarised as follows and additional information is provided below:

- Geophysical surveys (Appendix A.9.1)
- Well Condition Survey (Appendix A.10.1)
- Karst Survey (Appendix A.10.2)

Geophysical surveys were commissioned across the route of the proposed road development to provide additional detail on the subsurface ground conditions. These, along with the ground investigations discussed in **Section 10.2.5.3** were used to develop the hydrogeological conceptual model for the study area. The data for the geophysics surveys are presented in **Appendix A.9.1**.

A well condition survey was undertaken in 2014 to determine the condition of existing monitoring wells which were installed as part of the 2006 Galway City Outer Bypass (2006 GCOB) studies. This survey allowed historic wells, some of which required remediation, to be incorporated into the monitoring network for the proposed road development. The report on the condition of these wells is detailed in **Appendix A.10.1**.

Detailed karst surveys were completed for the constraints and route selection studies for the proposed road development in 2014. The karst survey was updated in July 2016 following completion of site walkovers and ground investigations (this updated report supersedes the karst Survey report included in the N6 Galway City Transport Project Route Selection Report, Arup 2016). The karst survey is presented in **Appendix A.10.2**.

10.2.5.3 Commissioned Ground Investigations

Five ground investigations were commissioned for the project. These ground investigations included boreholes, trial pits and window sampling, which are fully described **Chapter 9, Soils and Geology**. The ground investigations also included groundwater monitoring and groundwater testing. The full list of investigation is detailed in the following appendices:

- Groundwater Level Monitoring Report (June 2017) (Appendix A.10.3)
- Water Quality Monitoring Report (June 2017) (Appendix A.10.4)
- Aquifer Testing Report (June 2017) (Appendix A.10.5)
- N6 GCTP Phase I Ground Investigation Contract I, November 2014. Factual Report (Appendix A.9.1.2)
- N6 GCTP Phase II Ground Investigation Contract I, November 2015. Factual Report (Appendix A.9.1.3)
- N6 GCTP Phase III Ground Investigation Contract I, June 2017. Factual Report (Appendix A.9.1.4)

- N6 GCTP Phase III Ground Investigation Contract II, May 2016. Factual Report (Appendix A.9.1.5)
- N6 GCTP Phase III Ground Investigation Contract III, April 2017. Factual Report (Appendix A.9.1.5)

In summary, the hydrogeological investigations for the proposed road development comprised of the following project specific groundwater installations and testing:

- 34 No. groundwater monitoring wells
- 16 No. groundwater level monitoring rounds [1]
- 12 No. groundwater quality monitoring rounds
- 15 No. infiltration test
- 16 No. small scale pumping test and variable head permeability tests
- 3 No. Packer tests
- 1 No. step pumping test

All investigation locations were sited based on the design of the proposed road development. Groundwater level, groundwater quality and aquifer testing in particular was focused on locations of cuttings, structures and receptors.

10.2.6 Technical Limitations

The data included in the hydrogeology assessment includes existing information from earlier investigations in the region as well as dedicated field surveys, walkovers and ground investigations commissioned for the proposed road development. The data collected provides a comprehensive hydrogeological dataset along the route of the proposed road development. As is standard for hydrogeological studies the dataset comprises of point data (boreholes), linear data (geophysics) and surface data (topography, water courses and karst) to develop a conceptual model of the study area.

Where groundwater dependent receptors were identified, the locations were investigated to determine the hydrogeological regime. Due to the ecologically sensitive nature of sites the investigation methodologies selected were those that would not impact on the hydrogeology of a European site. In the absence of site specific data in these sensitive locations, a conservative approach was taken in appraising any potential impacts.

Based on the comparability of the ground investigation and the baseline data collection the information is deemed sufficient to complete the hydrogeology evaluation.

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[1] Groundwater monitoring was undertaken between February 2015 and April 2017. This included a total of 16 groundwater monitoring rounds. Measurements on individual wells were also taken during commissioning, well testing and spot checks. In total 54 individual wells were regularly measured, which comprised of 34 project specific wells, 16 (2006 GCOB wells and 4 private wells. Contractors also undertook a period of monitoring following the well installation for this project and their data is presented in the Ground Investigation Reports in **Appendix A.9.1**.

10.2.7 Impact Assessment Methodology

The TII Guidelines have been used to provide the criteria for the impact assessment during construction and operation of the proposed road development.

The rating of potential impacts from the proposed road development on the hydrogeological environment has been assessed by:

1. Classifying the importance of the relevant attributes (**Table 10.1**)
2. Quantifying the likely magnitude of any impact on these attributes (**Table 10.2**)
3. Determining the resultant significance (**Table 10.3**)

Table 10.1: Criteria for Rating Site Attributes - Estimation of Importance of Hydrogeology Attributes (TII, 2009)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. cSAC or SPA status
Very High	Attribute has a high quality or value on a regional or national scale	Regionally important aquifer with multiple well fields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer Groundwater provides large proportion of baseflow to local rivers Locally important potable water source supplying >1000 homes Outer source protection area for regionally important water source Inner source protection area for locally important water source
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer Potable water source supplying >50 homes Outer source protection area for locally important water source
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer Potable water source supplying <50 homes

Table 10.2: Criteria for rating impact significance at EIA stage – Estimation of magnitude of impact on hydrogeology attributes (TII, 2009)

Magnitude of Impact	Criteria	Typical Examples[1]
Large Adverse	Results in loss of attribute and/or quality and integrity of attribute	Removal of large proportion of aquifer Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems Potential high risk of pollution to groundwater from routine run-off[2] Calculated risk of serious pollution incident during operation >2% annually[3]
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Removal of moderate proportion of aquifer Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems Potential medium risk of pollution to groundwater from routine run-off[2] Calculated risk of serious pollution incident during operation >1% annually[3]
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Removal of small proportion of aquifer Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems Potential low risk of pollution to groundwater from routine run-off[2] Calculated risk of serious pollution incident during operation >0.5% annually[3]
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident during operation <0.5% annually[3]

1 Additional Examples are provided in the TII Guidance Document

2 refer to Method C, Annex 1, Annex 1 of HA"16/06

3 refer to Method D, Appendix B3/Annex 1of HA216/06

Table 10.3: Rating of Significant Environmental Impacts (NRA, 2009)

		Magnitude of Impact			
		Negligible	**Small**	**Moderate**	**Large**
Importance of Attribute	**Extremely High**	Imperceptible	Significant	Profound	Profound
	Very High	Imperceptible	Significant / Moderate	Profound / Significant	Profound
	High	Imperceptible	Moderate / Slight	Significant / Moderate	Profound / Significant
	Medium	Imperceptible	Slight	Moderate	Significant
	Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

The 2009 NRA significance ratings were designed to be in accordance with impact assessment criteria provided in the EPA publication Guidelines on the Information to be contained in Environmental Impact Assessment Reports (Environmental Protection Agency 2002 guidelines). However, it should be noted that the 2017 EPA guidelines include two additional 'Significance' rankings over previous EPA and the current TII guidance. The two additional rankings 'Not Significant' and 'Very Significant' ratings have not yet been incorporated by TII into the Significance ranking matrix (refer to **Table 10.3**) and as such the rating of significance used in this EIAR follows TII 2009 significance nomenclature and does not include 'Not Significant' nor 'Very Significant'. Where 'Not Significant' would apply based on EPA (2017) then Imperceptible is used for NRA (2009) and where 'Very Significant' would apply based on EPA (2017) then Profound is used for TII (2009).

The rating of significant environmental impacts is also assessed in terms of duration and frequency. With each impact described as being momentary, brief, temporary, short-term, medium-term, long-term or permanent. The frequency of effects is also described either in terms of reoccurrence (one, rarely, occasionally, frequently, constantly) or timing (hourly, daily weekly, monthly, seasonally or annually). If an effect is reversible, for example through remediation or restoration, then this is also described. Description of the durations are listed below:

- Momentary effects last from seconds to minutes
- Brief effects last less than one day
- Temporary effects last less than one year
- Short-term effects last one to seven years
- Medium-term effects last seven to fifteen years
- Long-term effects last fifteen to sixty years
- Permanent effects last over sixty years

In line with guidelines, following the assessment of potential impacts, specific mitigation measures are presented to avoid, reduce and remedy any negative impacts on the hydrogeological environment. These are described in **Section 10.6** below. Residual impacts which are the potential impacts which result after mitigation measures have been fully established and are described in **Section 10.7** below. The length of time it takes for each mitigation measure to take effect varies but they are designed to ensure that predicted impacts are minimal.

10.3 Receiving Environment Baseline

This section provides a characterisation of the hydrogeological receiving environment of the proposed road development. The hydrogeological environment is presented firstly in the regional context using publically available information and then secondly in detail for the study area based on information obtained specifically for the project.

Both the regional and site specific assessments document the hydrogeological characteristics of aquifer classification, groundwater vulnerability, recharge and groundwater receptors, such as aquifers, groundwater abstractions and groundwater dependant terrestrial ecosystems (GWDTE) (refer to the glossary of technical terms provided with this EIAR.

10.3.1 Regional Hydrogeology

The hydrogeological study area is divided into two main regions on the basis of the contrasting aquifer properties for the two main geological rock types in the region. As described in **Chapter 9, Soils and Geology**, the bedrock geology may be divided into:

- The Galway Granite Batholith (comprising of granite and orthogranite) underlies the western section of the proposed road development from the R336 west of Bearna Village to the N59 Moycullen Road
- The Visean Undifferentiated Limestone, which underlies the eastern section of the proposed road development from the N59 Moycullen Road to existing N6 at Coolagh

10.3.1.1 Western Section

The GSI bedrock aquifer map for the western section is presented in **Figure 10.1.001**. The GSI classification of the granite and orthogranite (including multiple dolerite dykes) of the Galway Granite Batholith are all classified to be Poor Aquifers that are only productive in local zones (Pl). Poor Aquifers generally provide little groundwater for water supply or for baseflow to surface water bodies. However, they are sometimes used for local supplies to individual houses/farms. The GSI assessment of the Galway Granite Batholith being a Pl aquifer is based on the low occurrence of high yielding groundwater wells and the abundance of surface water features as well as man-made drainage ditches.

Under the Water Framework Directive, the GSI have delineated a number of groundwater bodies (GWB) in Ireland. In the area of the Galway Granite Batholith there are two groundwater bodies, with their boundaries determined based on topography and surface watersheds (refer to **Figure 10.2.001**). The two groundwater bodies are:

1. Spiddal GWB
2. Maam-Clonbur GWB

The GSI describe both groundwater bodies as being overlain by blanket peat except in urban areas where the bedrock is overlain by man-made fill. Where the blanket peat is present then the overburden thickness is generally less than 3m.

The vulnerability of the groundwater body is the term used to describe the ease with which the groundwater in the area can be contaminated by human activities. The vulnerability is determined by many factors including the travel time, the quantity of contaminants and the capacity of the deposits overlying the bedrock to attenuate contaminants. These factors in turn are based on the thickness and permeability of the overburden e.g. groundwater in bedrock which is exposed at the surface. The criteria for determining groundwater vulnerability, as described by the GSI, is shown in **Table 10.4** below.

Table 10.4: GSI Groundwater Vulnerability Mapping Guidelines (DoELG 1999)

Vulnerability Rating	**Hydrogeological Conditions**				
	Subsoil Permeability (Type) and Thickness			**Unsaturated Zone**	**Karst Feature**
	High permeability (sand/gravel)	**Moderate permeability (e.g. Sandy subsoil)**	**Low permeability (e.g. Clayey subsoil, clay, peat)**	**(Sand/gravel aquifers only)**	**(<30m radius)**
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 - 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Notes: (1) N/A = not applicable.

(2) Precise permeability values cannot be given at present.

(3) Release point of contaminants is assumed to be 1-2m below ground surface.

The GSI data on groundwater vulnerability shown in **Figure 10.3.001**, shows that bedrock is often at or near surface (X or E category) for circa 25% of the western section of the proposed road development. Where cover is present on the granite bedrock it is generally thin (<3m), with rock outcropping on higher ground, and thick subsoil deposits (up to 6m) on lower ground. Peat bogs occur in a number of locations across the granite landscape, generally in low lying areas or hollows where surface water ponding is present. Where peat is present it will generally allow very limited recharge and promote horizontal flow to drains, ditches and water courses.

The combination of poor aquifer and Blanket bog cover, where rock is not exposed, limits the quantity of recharge that can infiltrate to ground. The recharge quantities are estimated by the GSI and are shown on **Figure 10.4.001**.

Met Éireann reports an annual average of 1,250mm of rainfall for the area and with losses by evapotranspiration accounted for (450mm/yr) then the available effective rainfall is 800mm (**Table 10.5** below). Given a recharge cap of 100m/yr for the Galway Granite Batholith only 12.5% of effective rainfall is available as recharge, with the remaining balance of 700mm/yr flowing to streams as either overland flow or shallow flow through the subsoil. The Galway Granite Batholith is a poor aquifer (Pl) with low recharge acceptance, with groundwater bodies that will match surface water drainage divides.

Table 10.5: Recharge assessment for the Galway Granite Batholith (Pl) (av mm/yr Met Éireann)

Vulnerability	Rainfall (mm/yr)	PE (mm/yr)	Effective Rainfall (mm/yr)	Recharge (mm/yr)	Runoff (mm/yr)
Granite and Orthogranite (irrespective of vulnerability)	1250	450	800	100	700

On the basis of the poor aquifer properties and the low likelihood of local productive zones, then actual recharge quantities for Galway Granite Batholith will not vary significantly from **Table 10.5**.

The GSI overburden thickness for the area shows that rock outcrops on topographic highs but in low lying areas the soils and subsoils are thicker, generally up to 5m thick. Generally, the aquifer properties (hydraulic conductivity and storage) will be low for the Galway Granite Batholith, especially on higher ground, where the rock is most competent. In low lying areas the aquifer properties remain poor but hydraulic conductivity may be locally productive due to weathering along fault lines.

Effective rainfall will generally run off to surface water by means of drains and ditches. In elevated areas the effective rainfall will rapidly run off the steeper gradient. In low lying areas the slight topographic gradients and thicker overburden is likely to cause impoundment of effective rainfall causing perching above the rock head with local ponding to surface.

The GSI descriptions of the Spiddal GWB and Maam - Clonbur GWB (GSI 2004a and 2004b) state that the water table is shallow in the Galway Granite Batholith and yields from wells are low. Groundwater flow paths are only in fractured and weathered zones, typically in the vicinity of faults. These pathways will be short and flow directions will follow topography towards watercourses. The GSI report flow paths in the Spiddal GWB to be up to 100m long whilst the Maam-Clonbur GWB to be 30-300m. Groundwater will discharge to streams and rivers but the baseflow contribution will be relatively low.

10.3.1.2 Eastern Section

The GSI bedrock aquifer map for the eastern section is presented in **Figure 10.1.002**. The GSI classify the Visean Undifferentiated Limestone as being a regionally important karstified aquifer, which is dominated by conduit flow (Rkc).

Regionally important aquifers are important groundwater resources. A regionally important bedrock aquifer is capable of supplying regionally important abstractions (e.g. large public water supplies), or 'excellent' yields (>400 m^3/d). The assessment by the GSI is based upon the occurrence of high yielding groundwater wells, the presence of karst landforms and features but also the relatively low abundance of surface water features and man-made drainage.

Under the Water Framework Directive, the GSI have delineated groundwater bodies (GWB) for Ireland. Those in the Visean Undifferentiated Limestone of the study area (refer to **Figure 10.2.002**) include:

1. GWDTE Lough Corrib Fen 1 (Menlough)
2. GWDTE Lough Corrib Fen 2
3. GWDTE Lough Corrib Fen 3 & 4
4. Clarinbridge
5. Clare-Corrib
6. Ross Lake

The Geological Survey of Ireland (GSI) national dataset for groundwater vulnerability (Refer to **Figures 10.3.001** and **10.3.002**) shows that the subsoil cover has a variable thickness across the Visean Undifferentiated Limestone. Generally, on higher ground the limestone either outcrops or is near surface but there are areas where significantly deeper overburden is identified, such as Coolagh Lakes, Ballindooley Lough, Terryland River and Lough Atalia. During the ground investigation for the 2006 Galway City Outer Bypass (GCOB, 2006) a number of areas with thick overburden were investigated by geophysics and drilling, these included areas near the River Corrib at Menlough as well as the north edge of Ballindooley Lough (**Appendix A.9.1** and **A.9.2**).

Adjacent to Ballindooley Lough, geophysics undertaken for the 2006 GCOB identified that whilst bedrock was near surface in the fields to the northwest and southeast of Ballindooley, in the valley floor itself the overburden was greater than 18m deep. Similar features of bedrock being near surface at one location but then a short distance away being significantly deeply buried were also encountered near the River Corrib at Menlough where drilling proved the overburden to be up to 70m thick. In these areas at Ballindooley and Menlough the morphology of the bedrock topography and burial by overburden can be described as being a buried valley, which is often referred to in academic texts as a palaeolandscape.

Related to the vulnerability mapping is the GSI recharge mapping. **Figure 10.4.002** shows the GSI quantification of recharge for the eastern section. Based on the GSI mapping the limestone aquifer has a significantly high infiltration capacity. Areas of outcrop are attributed a recharge rate of 85% (greater if karst present), with areas of thin overburden attributed 60% if the subsoil is of a moderate or high permeability. Those areas where the overburden is thicker and of low permeability, such as Coolagh Lakes, Ballindooley Lough, Terryland River and Lough Atalia then the recharge coefficient is estimated by the GSI as 15% or less. Due to the generally high recharge acceptance of the Rkc aquifer the GSI do not apply a recharge cap to the annual quantity of recharge. **Table 10.6** below presents regional estimates on recharge and run-off for the eastern section.

Table 10.6: Recharge assessment for the Visean Undifferentiated Limestone (Rkc) (av mm/yr Met Éireann)

Vulnerability	Recharge coefficient	Rainfall (mm/yr)	PE (mm/yr)	Effective Rainfall (mm/yr)	Recharge (mm/yr)	Runoff (mm/yr)
Limestone at (X) or near (E) surface	60-100%	1250	450	800	480-800	0-320
Moderate (M) or high (H) vulnerability	15-60%	1250	450	800	120-800	320-680
Low (L) vulnerability	<15%	1250	450	800	120	680

Limestone bedrock designated as regionally important karst with conduit (Rkc), has triple permeability characteristics, namely that hydraulic connectivity occurs via matrix, fracture and karst pathways (Waltham, 2005). Flow by the matrix of the rock is of a significantly low permeability and often lower than $1x10^{-7}$m/s. Flow by fractures can be variable but typically will range between $1x10^{-4}$m/s to $1x10^{-6}$m/s. Karst flow can be significant if conduits are present and generally flow in conduits is $1x10^{-3}$m/s or lower (Waltham, 2005).

On the basis of the Rkc classification by the GSI the bulk permeability of the aquifer is likely to be high but local areas of low or moderate permeability will exist where the aquifer has not developed karst enhancement Karst features are also discussed in **Chapter 9, Soils and Geology**.

It should be noted that some additional karst features are identified in this chapter which have not been included in **Chapter 9, Soils and Geology** due to the larger study area in the east for the hydrogeological assessment.

The hydrogeological assessment assesses those karst features which are either supporting the hydraulic regime of the area or specific receptors e.g. ecological features and these have been identified and discussed in S**ection 10.3.4**.

As well as supporting specific receptors, karst features such as enclosed depressions support the hydrogeology of an area by providing enhanced recharge (point input) at those locations.

As outlined in **Section 10.2.5.2**, a detailed karst survey of the scheme study area was undertaken as part of the constraints and route selection studies for the proposed road development and was updated for this assessment. The karst survey report is presented in **Appendix A.10.2**.

10.3.2 Local Hydrogeology within the Study Area

As highlighted in **Section 10.3.1** the footprint of the proposed road development is divided into two main geological units, which have contrasting aquifer, vulnerability and recharge characteristics. The western section of the proposed road development is underlain by the poorly productive (Pl), low recharge aquifer of the Galway Granite Batholith and the eastern section is underlain by the regionally important karstified (Rkc), high recharge aquifer of the Visean Undifferentiated Limestone.

When examining the receiving environment of the study area, the proposed road development has been divided into four sections to allow for ease of presentation and description of the underlying ground conditions due to the volume of information available. To allow for consistency, these sub-divisions were also applied in **Chapter 9, Soils and Geology**. The four sections are as follows:

- Section 1: R336 to the N59 Moycullen Road
- Section 2: N59 Moycullen Road to the River Corrib
- Section 3: River Corrib to the N83 Tuam Road[2]
- Section 4: N83 Tuam Road to the existing N6 at Ardaun, Coolagh

The ground investigations undertaken in each of the four sections were tailored to provide data that will allow hydrogeological assessment specific for the proposed road development in that section. For example, aquifer testing and groundwater monitoring wells were sited where cuttings would be required by the proposed road development whereas geophysics was used to determine the depth to bedrock or as an indicator for karst.

The information presented in this section forms the basis for **Section 10.3.3**, which develops a conceptual site model for the study area.

10.3.2.1 Section 1 – R336 to N59 Moycullen Road (Ch. 0+000 – 7+600)

Section 1 of the proposed road development is situated on the Galway Granite Batholith. The topography of Section 1 is undulating with the highest point of 100mOD forming part of a northwest to southeast ridge at Letteragh. This ridge also marks the watershed for surface water and groundwater sub catchments. West of the ridge all the surface water drainage and the Spiddal GWB drain southwards to Galway Bay, whilst east of the ridge all surface water all the Maam-Clonbur GWB drain eastwards to the River Corrib (**Figure 10.2.001**).

Bedrock Aquifer

As identified in the section on regional hydrogeology, the Galway Granite Batholith is a poor aquifer (Pl) that is locally productive in local zones such as faults (**Figure 10.1.001**). Where faults are present then these tend to form areas of deeper subsoil in low lying ground.

[2] Formally known as the N17 Tuam Road

The geophysics undertaken included electrical resistivity tomography (ERT) and seismic surveying, this data is presented in **Appendix A.9.1**. As presented in the **Chapter 9, Soils and Geology**, the ERT survey shows that the bedrock is generally shallow and of high resistivity, indicating competent rock. There are shallow zones where lower resistivity is measured. These may indicate areas of increased weathering along vertical features such as faults where there is a localised linear feature that may have increased storage of groundwater.

Shallow features (<10m) can be observed on the mainline of the proposed road development at Ch. 5+500 and Ch. 7+750, as well as a deeper feature (c.20m) on the N59 Link Road North (LNR) at Ch. 0+250 LNR. These features are likely to be zones locally productive with groundwater. The unconformity contact between the Galway Granite Batholith and the Visean Undifferentiated Limestone is marked by a sharp change in slope at Ch. 8+890, which also conforms to a deep vertical feature in the ERT profile at Ch. 8+920. This feature is developed in the limestone side of the contact with the granite and as such is described in **Section 10.3.3.2**.

The seismic survey is used to identify the top of competent bedrock and as such is a good indicator for the thickness of the combined overburden and weathered layer. The seismic data shows that competent bedrock is generally 2-3m in depth, being slightly deeper (up to 5m) in low lying areas.

Aquifer Properties

Aquifer testing was undertaken in five monitoring boreholes in the Galway Granite Batholith. These tests were small scale pumping tests so that observation could be made on the drawdown in the well as well as monitoring of the recovery as a rising head test. The data from the test as well as analysis of the rising head test are presented in **Appendix A.10.5**. This data shows that the water level in the wells was drawn down fairly rapidly at a low abstraction rate, which is indicative of low hydraulic conductivity. Measurement of the recovery of the wells indicates a range of hydraulic conductivity in the Galway Granite Batholith between 9.7×10^{-7} and 4.6×10^{-6}m/s.

Groundwater Vulnerability

Comparison of GSI vulnerability and information from GI and walkover surveys identifies that at topographic highs rock is generally at or very near surface. Borehole records confirm that the depth to bedrock increases away from topographic highs. The ground investigation and walkover surveys generally confirm with the vulnerability mapping by the GSI for the Galway Granite Batholith (**Figure 10.3.001**). Approximately 40% of the route of the proposed road development in Section 1 has rock at or near surface based upon GSI vulnerability mapping.

As presented in the regional hydrogeology, recharge quantities are low for the available effective rainfall. This is due to the peaty blanket bog which is of low permeability and will promote runoff, but also due to the relatively thin weathered zone and low aquifer properties of the aquifer. The GSI recharge cap of 100mm/yr is considered appropriate based on site observation and the aquifer tests undertaken (**Figure 10.4.001**).

Groundwater Levels

Groundwater level monitoring was initiated in February 2015 for existing wells. New monitoring wells, installed as part of the studies for the proposed road development, were monitored from November 2015. The monitoring continued on all wells to January 2017. Due to the shallow or non-existent nature of the overburden in this area, the monitoring wells all have their response zones in the Galway Granite Batholith.

A review of pre-existing wells was undertaken early in 2014 and the commissioning report from this survey is presented in **Appendix A.10.1**. A report of all groundwater level data used in the assessment is presented in **Appendix A.10.3**. The groundwater level data from **Appendix A.10.3** is presented on the cross-sections as groundwater contours in **Figure 10.6.001** to **10.6.006** for the mainline of the proposed road development and **Figure 10.6.012** for the N59 Link Road (North and South). These profile cross sections confirm that the groundwater along the proposed road development is generally near the surface. A summary table of minimum and maximum groundwater levels monitored in Section 1 is presented in **Table 10.7** below.

In higher ground the water table is within 2m of ground level and on lower lying ground the water table is at ground level. Areas of low lying ground typically include saturated peat with ponding at surface caused by naturally poor drainage. Due to the low aquifer properties of the granite, interaction between groundwater and surface water is minimal. A summary table of minimum and maximum groundwater levels monitored in Section 1 is presented in **Table 10.7** below.

Table 10.7: Groundwater levels measured in the Galway Granite Batholith (Section 1)

Monitoring Borehole	Source	East (ITM)	North (ITM)	Ground Elevation (mOD)	Groundwater Level		
					Min (mOD)	Max (mOD)	Range (m)
RC422	N6 GCOB	524196	724742	21.20	19.45	20.75	1.30
RC435	N6 GCOB	524479	725777	59.19	56.13	56.58	0.45
RC451A	N6 GCOB	525153	726691	71.70	69.43	70.04	0.61
RC 548	N6 GCOB	521102	723826	50.84	49.67	50.73	1.06
RC 687	N6 GCOB	522901	725359	69.56	68.78	69.16	0.38
RC 739	N6 GCOB	524763	725951	59.64	58.45	58.86	0.41
BH-3-04R	N6 GCRR	523646	724287	36.82	36.23	36.70	0.47
BH-3-06R	N6 GCRR	524241	724825	23.09	21.87	22.22	0.35
BH-3-08R	N6 GCRR	524621	725069	42.05	39.85	41.39	1.54
BH-3-10R	N6 GCRR	525321	725604	66.51	63.37	64.66	1.29

Monitoring Borehole	Source	East (ITM)	North (ITM)	Ground Elevation (mOD)	Groundwater Level		
					Min (mOD)	Max (mOD)	Range (m)
BH-3-11R	N6 GCRR	525784	725831	54.24	52.83	53.27	0.44
BH-3-13R	N6 GCRR	526079	726036	58.65	52.85	57.12	4.27
BH-3-16R	N6 GCRR	526765	726611	61.66	57.64	58.45	0.81
BH-3-17R	N6 GCRR	527021	726805	65.33	62.46	62.93	0.47
BH-3-18R	N6 GCRR	527254	726894	70.64	68.03	69.11	1.08
BH-3-20R	N6 GCRR	527214	727669	51.63	47.83	48.61	0.78
BH-3-23R	N6 GCRR	527774	727346	26.93	22.32	23.46	1.14
BH-3-24R	N6 GCRR	528036	727521	25.16	20.97	22.77	1.80

Notes:

Includes groundwater level data from project specific monitoring wells

Groundwater levels are measured on site to the nearest centimetre below top of casing. All effort has been made to ensure the accuracy of the data.

Seasonal fluctuation is generally within 1.5m for higher ground but minimal in lower ground where the water table generally remains at surface throughout the year. Exception to this generalisation is borehole BH-3-11 near the Rahoon Road, which shows up to 4m of seasonal fluctuation. The higher seasonal fluctuation at BH-3-11 is considered to be natural and a factor of the narrow ridge within which the borehole is located.

Groundwater elevations confirm that groundwater flow follows the general topography and surface water drainage. In the Spiddal GWB the groundwater contours conform to the surface water drains and flow towards Galway Bay by seeping into the surface water courses that drain the area. In the Maam-Clonbur GWB the groundwater contours also conform to surface topography and surface water drainage and flow eastwards to the River Corrib.

In the steep eastern granite slopes draining towards the River Corrib there are a number of seepages, which emerge where the topography steepens and intersects the groundwater table. The largest of these is spring at W1000-01 (**Figure 10.5.001**), which is used as a private water supply (see **Section 10.3.4)**. Other smaller seepages occur in both groundwater bodies and these drain to surface water streams and ditches.

Seepages in the Galway Granite Batholith are generally associated with weathering and/or fault zones (refer to **Chapter 9, Soils and Geology**) and generally the seepages dry out in the summer. As per GSI descriptions (2004a and 2004b) these locally productive pathways are considered to be relatively short and to have limited lateral extent. On this basis, they are likely to have limited storage and rely on recharge, which would suggest they will respond to storm events and reduce in flow during the summer (GSI 2004a and 2004b).

Based on GSI descriptions of groundwater bodies in granite the length of the flow paths is considered to have a general maximum of 100m but in extreme cases where significant faulting is present then they may extend up to 300m.

Water Quality

Water sampling from monitoring wells in the Galway Granite Batholith indicates that the groundwater is generally of good quality with moderate levels of calcium and magnesium. There are local detections of bacteria such as faecal coliform, which is most likely agricultural or from poorly operating domestic wastewater treatment plants. Water quality data is presented in **Appendix A.10.4**.

10.3.2.2 Section 2 - N59 Moycullen Road to River Corrib (Ch. 7+600 – 9+300)

Between the N59 Moycullen Road and the River Corrib there is a narrow section of limestone (**Figure 10.1.001**). This strip of limestone bedrock comprises the Ross Lake GWB (**Figure 10.2.001**), which extends 3km northwest to Kentfield.

Input to the aquifer comprises of recharge to the limestone area (1.5km^2), and also runoff from the granite slopes of the Maam-Clonbur GWB (3km^2), which flows down slope and onto the limestone. There is a significant amount of urban development in this area and it is likely that some streams are culverted below developments to the River Corrib, others may infiltrate into the limestone.

Bedrock Aquifer

The contact between the Galway Granite Batholith and the Visean Undifferentiated Limestone is an unconformity (GSI Geology Memoir). The ERT geophysics data for the contact is shown in geophysics profile 3/5 (GP3/5) confirms the contact between granite and limestone at Ch. 8+890 to be vertical and sharp. The geophysics profile matches a distinct change in the topography and indicates that the contact slopes steeply eastwards.

The depth to rock in the limestone is significantly more variable than the granite bedrock. The vertical nature of the low resistivity feature and general vertical steps in the rock topography indicates that the limestone may be locally faulted and / or fractured.

Groundwater flow is likely to be dominated by fracture flow but the low resistivity feature in the limestone near the contact between granite and limestone indicates likely karstification and possible conduit flow. There are a number of small scale karst landforms located between the N59 Moycullen Road and the River Corrib, which include small enclosed depressions (K10, K11 and K12) and small springs (K2, K7 and K9).

No site specific groundwater level or aquifer properties data were collected in Section 2. As outlined in **Section 10.2.5.3** groundwater level, aquifer properties and groundwater quality monitoring was focused on areas of cutting or dewatering of the bedrock aquifer. This section of the proposed road development is entirely on embankment and geophysics was the primary investigative tool used, with boreholes (BH3/23 and BH3/24) installed to calibrate the geophysical data.

Groundwater Vulnerability

The criteria for determining groundwater vulnerability, as described by the GSI, is shown in **Table 10.4**. Groundwater vulnerability as mapped by the GSI is presented in **Figure 10.3.001**. Comparison of GSI vulnerability and information from GI and walkover surveys indicate that the data sets are consistent in this area.

Key inferences from the vulnerability mapping are: the confirmation that the depth of rock head increases towards the River Corrib and that recharge is higher where the bedrock is shallower (this infers that effective rainfall increasingly runs off to surface water closer to the river) (**Figure 10.4.001**).

10.3.2.3 Section 3 - River Corrib to N83 Tuam Road (Ch. 9+300 – 14+000)

Section 3 of the proposed road development comprises the area between the River Corrib and the N83 Tuam Road. This area encompasses of the GWDTE Lough Corrib Fen 1 Groundwater Body (GWB), GWDTE Lough Corrib Fen 2 GWB, GWDTE Lough Corrib Fens 3 and 4 GWB and the Clare Corrib GWB (**Figure 10.2.001**). The use of GWDTE in naming for these groundwater bodies by the GSI does not signify that the GWB is a GWDTE but rather because GWDTE do receive groundwater from these GWB.

The topography of Section 3 is undulating with the highest point being 40m OD immediately west of Lackagh Quarry. There are also extensive lowland areas at Coolagh Lakes, Ballindooley Lough and Terryland River.

Bedrock Aquifer

As identified by the regional hydrogeology the eastern section of the proposed road development is underlain entirely by the Visean Undifferentiated Limestone, which is a regionally important karst aquifer (Rkc) (**Figure 10.1.002**).

The GSI karst database includes a national record of all karst landforms, which identifies that turloughs, dolines, stream sinks and one cave have been recorded in the area. The karst survey (**Appendix A.10.2**) referred to previously characterises the type of landforms.

Aquifer Properties

The Visean Undifferentiated Limestone aquifer is a regionally important aquifer that is associated with a high permeability and very productive groundwater abstraction wells. Abstraction rates of wells identified in the study area are particularly high confirming the characteristics of the aquifer.

The GSI have characterised the aquifer as having a high recharge coefficient (85%) with high infiltration rates and no recharge cap. The Rkc characterisation by the GSI is due to the presence of karst. Although karst is present (refer to **Appendix 10.2** Karst survey report) observations from quarries and bedrock exposure indicate a moderate to high frequency of fracturing in the bedrock. Based on the relatively high fracture frequency then fracture flow, as opposed to conduit flow, is considered to be the most common pathway in the limestone aquifer.

Aquifer testing was undertaken in six monitoring boreholes in Section 3. These tests were small scale pumping tests so that observation could be made on the drawdown in the well as well as monitoring the recovery as a rising head test. The data from the drawdown test as well as analysis of the rising head test, are presented in the aquifer testing data. This data is variable showing a wide range of response to the drawdown and recovery.

Measurement of the recovery of the wells indicates a non-karst range of hydraulic conductivity in the Visean Undifferentiated Limestone between 3.1×10^{-5} and 5×10^{-9}m/s. The higher permeability is likely to be testing fracture flow or small scale conduit flow in the aquifer, whilst the lower permeability values indicate the borehole mainly represents matrix flow.

Section 3 includes surface karst features, such as enclosed depressions (dolines), estavelles, turloughs, limestone pavement, springs, and one cave. Karst features are presented in **Figure 10.1.002** and detailed in the Karst Survey Report (**Appendix A.10.2**). The karst features located in Section 3 can be divided into those between Menlough and Ballindooley as well as those associated with the Terryland River.

There are a number of karst features between Menlough and Ballindooley including springs, turloughs and enclosed depressions. There are two karst springs (K17 and K25). Of these K17 is a small spring with a discharge too slight to gauge that discharges to Lough Corrib, whilst K25 (referred to as Western Coolagh Spring) is a more significant spring and is the main groundwater supply to the Upper Coolagh Lake.

During the site workover, a pond with a ditch outfalling to the Upper Coolagh Lake was identified as being a potential spring and this is referred to as the Eastern Coolagh Spring (K45). However, this spring is not a karst spring because it sits on clay subsoil as evidenced by GI. Monitoring of the water level between 2014 and 2018 at the Eastern Coolagh Spring showed the water level is static and failed to identify a correlation with groundwater levels in bedrock. The Eastern Coolagh Spring (K45) is instead supplied by a combination of seepage via the subsoil and surface water runoff. There is no bedrock exposed at the Eastern Coolagh Spring and due to the thick cover of clayey subsoil it is unlikely there is any direct discharge from the limestone aquifer to the Eastern Coolagh Spring.

There are three turloughs between Menlough and Ballindooley, two near Menlough (K20 and K31) and one (K72) near Ballindooley. There are a number of enclosed depressions across the area, which are sometimes associated with limestone pavement (for locations of limestone pavement refer to **Chapter 8, Biodiversity**). Other karst features in the area include a small estavelle adjacent to Ballindooley Lough (K86) and a dug karst feature (K92) that like K86 has a free water surface that fluctuates seasonally.

The Terryland River bifurcates from the River Corrib near Quincentenary Bridge and drains eastwards along the low lying ground through Terryland towards Ballybrit. Under normal conditions the Terryland River sinks at two stream sinks, named Pollavurleen West and East (K87 and K96) near Glenanail (Refer to karst study in **Appendix A.10.2**).

Section 3 also includes areas of thick subsoil, including those from the 2006 GCOB investigation at Menlough and Ballindooley Lough that are interpreted as being buried landscapes. Based on geophysics and drilling from the project specific ground investigation, buried landscapes have been identified in the townland of Coolagh (Menlough), Coolagh Lakes, Ballindooley Lough, Castlegar and the N83 Tuam Road (refer to **Chapter 9, Soils and Geology**). Some of these buried landscapes are palaeokarst features, i.e. karst that had developed in the bedrock but subsequently was buried by thick accumulations of sediment.

Groundwater Vulnerability

The GSI vulnerability mapping for Galway is presented in **Figure 10.3.002**. Buried features are identified on these maps as where present they will modify the vulnerability locally to low. A number of areas where buried features have been identified, for example the buried features at Menlough and N83 Tuam Road, the GSI vulnerability had been mapped as high or extreme. In light of the buried features, their vulnerability is considered to be low. These areas also have significantly reduced recharge and a corresponding increase in run-off (**Figure 10.4.002**).

Groundwater Levels

Groundwater monitoring has been undertaken in the Menlough and Ballindooley area since February 2015 for existing wells and since November 2015 for new monitoring wells installed as part of the environmental studies for the proposed road development. A review of the condition of existing monitoring wells is presented in **Appendix A.10.1** and the groundwater level data for Section 3 is presented in **Appendix A.10.3**. This data is plotted in **Figures 10.6.007** to **10.6.010** Summary groundwater levels for Section 3 of the proposed road development are presented below in **Table 10.8**.

Table 10.8: Groundwater levels measured in the Visean Undifferentiated Limestone (Section 3)

Monitoring Borehole	Source	Easting ITM	Northing ITM	Ground Elevation (mOD)	Groundwater Level		
					Min mOD	Max mOD	Range m
Western Coolagh Spring	N6 GCRR (SW-2-4)	529045	727934	5.41	5.70	6.37	0.67
Eastern Coolagh Spring	N6 GCRR (SW-2-5)	529900	728162	7..06	7.65	7.78	0.13
MW 01	2006 GCOB	528670	727956	16.14	10.61	13.89	3.28
MW 02	2006 GCOB	528715	728095	13.37	6.15	7.90	1.75

Monitoring Borehole	Source	Easting ITM	Northing ITM	Ground Elevation (mOD)	Groundwater Level		
					Min mOD	Max mOD	Range m
MW 03	2006 GCOB	528920	727970	6.70	5.80	6.46	0.66
BH-3-27R	N6 GCRR	528960	728133	9.10	5.90	6.41	0.51
RC133	2006 GCOB	529325	728185	11.66	5.73	8.16	2.43
BH972	2006 GCOB	529462	728292	12.33	5.70	8.20	2.50
BH-3-29R	N6 GCRR	529489	728334	13.73	Dry (<6.93)	9.23	>2.40
RP-2-05D	N6 GCRR	529701	727145	19.96	5.73	7.78	2.05
RP-2-05S	N6 GCRR	529704	727141	20.22	8.86	12.01	3.15
BH04	N6 GCRR	530151	728400	32.17	8.20	15.74	7.50
BH05	N6 GCRR	530187	728378	34.14	8.08	19.46	11.40
LQ MW6	Private	529919	727971	15.40	12.11	13.20	1.09
LQ MW5	Private	530389	728285	7.40	10.71	19.17	8.46
LQ MW4	Private	530522	728557	16.76	8.71	15.41	6.70
RC 1104	2006 GCOB	531165	728927	9.39	7.24	7.83	0.60
BH-3-31R	N6 GCRR	531274	728424	11.08	9.45	9.78	0.33
RC206	N6 GCRR	531237	729433	28.49	19.29	21.11	1.82
RP-2-03	N6 GCRR	531478	728278	22.44	4.95	9.09	4.14
RP-2-01	N6 GCRR	531726	728689	21.38	7.86	10.28	2.42
RC 1206	N6 GCRR	531986	729388	27.67	17.05	19.45	2.40
BH-3-32R	N6 GCRR	531971	728318	24.43	Dry (<9.43)	10.24	>0.81
RC 1211	N6 GCRR	532454	729601	25.91	20.25	22.03	1.78
BH-3-34R	N6 GCRR	532405	728275	32.57	19.69	25.91	6.22
BH-3-35R	N6 GCRR	532851	728226	17.52	7.91	9.15	1.24

Notes:
Includes groundwater level data from project specific monitoring wells
Groundwater levels in LQMW4 are the same as LQMW1, 2, 3 and 4.
It was not possible for IGSL to access to BH-2-32R during May, August, September and November 2016. Water levels for April, June and July are reported. As the groundwater levels recorded during these months are representative of low groundwater levels only 'not representative'(NR) is reported for the maximum groundwater level.
Monitoring wells LQMW5 and BH05 both straddle a thin black argillaceous limestone that overlies a clay wayboard in the geology sequence, which perches recharge above the main groundwater body. The groundwater levels recorded in LQMW5 and BH05 represent

interaction between the main groundwater body and recharge. The water levels in LQMW5 and BH05 are not representative of groundwater levels in the main groundwater body.

Groundwater levels are measured on site to the nearest centimetre below top of casing. All effort has been made to ensure the accuracy of the data.

Figures 10.6.007 to **10.6.110** show the groundwater level between River Corrib and the N83 Tuam Road to form an undulating groundwater table with low points at the River Corrib, Coolagh Lake and RP-2-03 at Castlegar. These low points in the groundwater table form areas where groundwater flows towards. Between these groundwater low points are groundwater highs. The main groundwater high in Section 3 is plotted between Menlough and Lackagh Quarry. At this location the water table forms a divide between westward groundwater flow towards Coolagh Western Spring, which feeds Coolagh Lakes, and eastward flow to the groundwater low at monitoring well RP-2-03. A second lesser groundwater high occurs between Coolagh Lakes and the River Corrib. This local water table high forms a groundwater divide between Coolagh Western Spring and the River Corrib.

The range in groundwater levels shown in **Table 10.8** shows differing seasonal variability in the Visean Undifferentiated Limestone across Section 3. Discounting those monitoring wells where the recorded range was not representative (refer to notes in **Table 10.8**) (BH-3-29R, BH3-31R LQMW5, BH05 and BH-3-32R), then the minimum and maximum ranges recorded are 7.54m (BH04) and 0.51m (BH-3-27R). BH04 is located close to the groundwater dive between Menlough and Lackagh Quarry, whilst BH-3-27R is located close to Western Coolagh Spring. Based on the data presented, those monitoring locations close to discharge points (rivers and springs) show the least seasonal fluctuation, whilst those near groundwater divides have the greatest seasonal fluctuation.

The data collected for the project and the identification of groundwater divides presented in **Figure 10.6.007** to **Figure 10.6.010** provides significant new data for the extent and boundaries of the groundwater bodies as defined by the GSI. **Section 10.3.3** of this chapter provides reinterpretation for the extents of the GWDTE Lough Corrib Fen 1 (Menlough) GWB, GWDTE Lough Corrib Fen 2 GWB, GWDTE Lough Corrib Fen 3 & 4 GWB and the Clare-Corrib GWB.

Water Quality

Water sampling from monitoring wells in the Menlough and Ballindooley area indicates that the groundwater is generally of good quality with high levels of calcium and magnesium. There are local detections of bacteria such as faecal coliform, which is most likely agricultural or from poorly operating domestic wastewater treatment plants. Water quality data is presented in **Appendix A.10.4**.

10.3.2.4 Section 4 – N83 Tuam Road to existing N6, Coolagh (Ch. 14+400 – 17+500)

Section 4 of the proposed road development extends between the N83 Tuam Road and the existing N6 at Coolagh, Briarhill (**Figures 10.2.002**). This section of the proposed road development traverses the GSI GWDTE Lough Corrib Fens 3 & 4 GWB and the Clarinbridge GWB. There is a significant amount of urban development in this area, which includes the Galway Racecourse. There are no surface water features apart from seasonal pluvial flooding on the existing N83 Tuam Road during winter.

The ground investigation identified that the subsoil at the N83 Tuam Road overbridge has a thickness in excess of 30m which is confirmed by boreholes (RC-3-62 & BH-3-35) and geophysics (GP-3-13 and GP-3-14) (**Appendix 9.2**). There is significant thickness of subsoil in the valley floor (below the fields) but bedrock is shallow along the School Road in Castlegar (BH3/33 and BH3/34) and Galway Racecourse (BH3/36, BH3/47). This indicates that a significant buried landscape is located along the existing N83 Tuam Road. The pluvial flooding that occurs seasonally along the N83 Tuam Road occurs where the areas of thick subsoil are present. Trial pits and soakaway tests into the valley floor of the N83 Tuam Road (SW3/02, SW3/15, SW3/16, SW3/17, SW3/18) confirm that the subsoil is of clay and as such of low permeability.

The buried landscape identified at the N83 Tuam Road is the only feature observed in Section 4. East of the feature the bedrock rises steeply and forms high ground that forms the Galway Racecourse and business parks in Ballybrit and Parkmore.

Bedrock Aquifer

Section 4, like sections 2 and 3 is classified by the GSI as being a regionally important karst aquifer with conduit (Rkc) (**Figure 10.1.002**). Ground investigations (GI) include geophysics, drilling and trial pitting Groundwater monitoring wells have been installed into boreholes and included as part of the groundwater monitoring network. Section 4 is generally absent of karst, with only a number of small scale features, which are shown in **Figure 10.1.002**. The recorded karst features include:

- Two small enclosed depressions east and north of the Galway Racecourse (K104 and K131)
- Three shallow enclosed depressions north of the existing N6 Coolagh Roundabout ((K172, K175 and K179)
- Small seepages and small enclosed depressions west of the existing N6 Coolagh Roundabout (K126, K129, K130, K132, K134 and K135)
- Further south and downgradient of the existing N6 Coolagh Roundabout an old quarry has some small scale inflows (K160 and K173), there are some shallow enclosed depressions (K112, K140, K142, K145, K151, K152, K154, K159, K163) and there is one spring (K182)

- Further east and downgradient of the existing N6 Coolagh Roundabout there are a number of small scale karst features, including enclosed depressions (K198, K201, K202, K203, K213, K211, K222 and K215) and one spring K215

Aquifer Properties

The Visean Undifferentiated Limestone aquifer is a regionally important aquifer that is associated with high permeability and highly productive groundwater abstraction wells.

Aquifer testing was undertaken in four monitoring boreholes located in Section 4. These tests consisted of three small scale pumping tests and one 72-hour pumping test. The data from and analysis of the tests is presented in the aquifer testing report **Appendix A.10.5**. It is noted that the 72-hour test undertaken in December 2016 failed to last the intended duration as the well became dry after a short period and did not recharge. A summary of the aquifer properties is presented below in **Table 10.10** and **Plate 10.1**.

This aquifer data shows a range in hydraulic conductivity in the Visean Undifferentiated Limestone of Section 4 between $1.7x10^{-6}$m/s and $4.2x10^{-7}$m/s. The higher permeability values are likely to be testing fracture flow, whilst the lower permeability values indicate mainly matrix flow with only small scale fractures intersected.

Groundwater Vulnerability

The criteria for determining groundwater vulnerability, as described by the GSI, is shown in **Table 10.4**. Groundwater vulnerability as mapped by the GSI is presented in **Figure 10.3.002**.

GSI vulnerability shows the rock within three meters of surface at the N83 Tuam Road to the Galway Racecourse and then mainly at or near surface from Briarhill to the existing N6. Information from ground investigations and walkover surveys indicates that the bedrock is significantly deeper than this at N83 Tuam Road where the deep buried valley is present and slightly deeper on the higher ground where thicknesses range from at surface to within 8m below ground level.

The GSI show that recharge estimates indicate a recharge coefficient of 30% for the limestone with thicker subsoil and 85% for the limestone at or near surface, with no recharge cap applied. Recharge acceptance of the Briarhill area is considered to have high recharge acceptance of 172-649mm/yr.

Groundwater Levels

Groundwater monitoring wells are located along the route of the proposed road development from N83 Tuam Road to the existing N6. The location of these wells and the water level data is presented in **Appendix A.10.3** and groundwater levels are presented **Figure 10.6.010** and **Figure 10.6.011**. The groundwater level for Section 4 of the proposed road development has a higher elevation than elsewhere on the limestone section of the proposed road development. A summary of the groundwater levels is presented below in **Table 10.9**.

Table 10.9: Groundwater levels measured in the Visean Undifferentiated Limestone (Section 4)

Monitoring Borehole	Source	East ITM	North ITM	Ground Elevation (mOD)	Groundwater Level		
					Min mOD	Max mOD	Range m
BH-3-36R	N6 GCRR	533125	728205	24.43	42.55	43.83	1.28
RC-2-02	N6 GCRR	533685	728102	25.91	39.30	39.89	0.59
BH-3-38R	N6 GCRR	534249	727541	32.57	39.17	39.32	0.15
BH-3-40R	N6 GCRR	534439	727295	17.52	37.51	38.36	0.85
BH-3-48R	N6 GCRR	534397	727197	51.78	29.50	30.12	0.62
BH-3-41R	N6 GCRR	534580	727065	54.92	42.55	43.83	1.28
BH-3-42R	N6 GCRR	534756	726840	45.17	39.30	39.89	0.59

Notes

Includes groundwater level data from project specific monitoring wells

Groundwater levels are measured on site to the nearest centimetre below top of casing. All effort has been made to ensure the accuracy of the data.

The water level data collected for the project and the identification of groundwater divides presented in **Figure 10.6.010** and **Figure 10.6.011**, provides significant new data for the extent and boundaries of the groundwater bodies as defined by the GSI. **Section 10.3.3** of this chapter provides reinterpretation for the extents of the Lough Corrib Fen 3 & 4 GWB, the Clare-Corrib GWB and the Clarinbridge GWB.

Water Quality

Water sampling from monitoring wells in Section 4 indicates that the groundwater is generally of good quality with high levels of calcium and magnesium. There are local detections of bacteria such as faecal coliform, which is most likely agricultural or from poorly operating domestic wastewater treatment plants. Water quality data is presented in **Appendix A.10.4**.

10.3.3 Conceptual Site Model

This section considers all desk study data together with the project specific surveys and ground investigations to develop a conceptual model for the hydrogeology of the study area. The conceptual model includes a refinement of the existing GSI groundwater bodies map based on interpretation of the project data. The updated map showing revised extents of groundwater bodies is used in the individual assessments for groundwater receptors, which follows this section.

The Galway Granite Batholith and Visean Undifferentiated Limestone contrast strongly in terms of aquifer classification, recharge and flow pathways and as such are considered as two distinct aquifer units.

The Galway Granite Batholith is classified as a poor aquifer (Pl) by the GSI and the investigation undertaken as part of this project confirms this. Aquifer testing has shown that the rock type generally has a low permeability but can locally have zones where permeability is higher.

The Visean Undifferentiated Limestone is classified by the GSI as a regionally important karst aquifer (Rkc) that includes conduits. The ground investigation has shown that the Visean Undifferentiated Limestone has a wide permeability range and whilst there are zones of karst there are also areas where no karst features exist.

An overview of the Galway Granite Batholith and Visean Undifferentiated Limestone aquifer is presented below, which is based on the regional and local data presented in **Section 10.3.1** and **Section 10.3.2**. The hydrogeology for the Galway Granite Batholith and the Visean Undifferentiated Limestone are then discussed in detail individually below.

Groundwater flows can be more complex in limestone than granite due to karst pathways and the ground investigation data includes aquifer testing of both rock types to calculate their range of hydraulic conductivity. The aquifer testing is presented in **Plate 10.1** below for granite and limestone. This data shows that whilst the granite has a relatively narrow range of values, the limestone spans a significantly wider range. For the limestone areas, this data (as well as the spatial distribution of karst features) is used to identify those areas where karst flow paths through the aquifer are likely but also areas where such pathways are not present. These assessments are based on a combination of trial pits, window samples, drilling, surface geophysical surveys, pumping test and groundwater monitoring and interpretation.

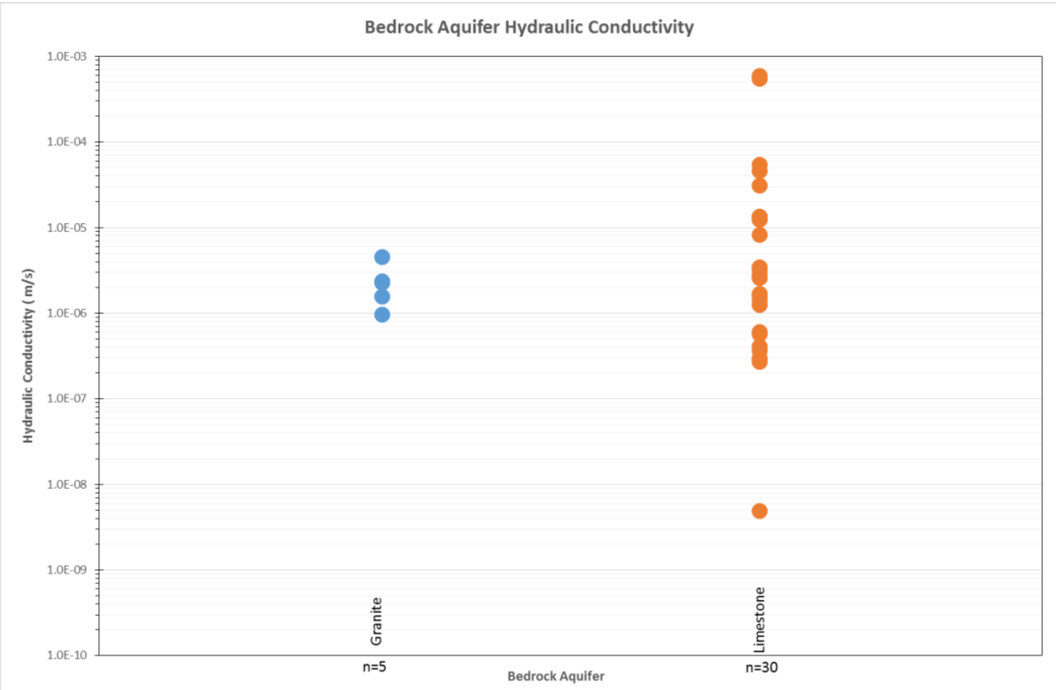
The karst survey (**Figure 10.1.002**) undertaken is used as an indicator that karst pathways are present within groundwater bodies. The observation of conduit flow at Western Coolagh Spring (K25) data and presence of karst features in the area are indicative that karst pathways are likely within GWDTE Lough Corrib Fen 1 (Menlough) GWB. Similarly, the karst survey identifies karst landforms across the Clare-Corrib GWB, which is also likely to have conduit pathways in the GWB. However, the survey identified only small scale karst features in the Clarinbridge GWB, which comprised of small or shallow enclosed depressions and seepages rather than springs.

Aquifer testing was undertaken for both the Galway Granite Batholith and Visean Undifferentiated Limestone across the proposed road development. The data from one pumping test, 15 small scale pumping tests with recovery, three packer tests and 15 soakaway tests are presented in **Appendix 10.5**. **Plate 10.1** below shows the distribution of hydraulic conductivity and **Table 10.10** shows the distribution for both granite and limestone. This data shows that those groundwater bodies that do not have karst, the Galway Granite Batholith and the Visean Undifferentiated Limestone within the footprint of the proposed road development within the Clarinbridge GWB have a relatively narrow range of hydraulic conductivity. In contrast the Visean Undifferentiated Limestone aquifer has significant karst in the GWDTE Lough Corrib Fen 1 (Menlough) GWB, the GWDTE Lough Corrib Fen 2 GWB and the Clare-Corrib GWB. In these areas where karst is present then the range of hydraulic conductivity is wider. Notably the maximum hydraulic conductivity is an order of magnitude higher. The highest recorded values for hydraulic conductivity are those measured in karst (5.3×10^{-4}m/s).

Table 10.10: Distribution of calculated hydraulic conductivity

Geological Unit	GWB	Min hydraulic conductivity m/s	Max hydraulic conductivity m/s
Galway Granite Batholith	Spiddal Maam - Clonbur	9.7 x10-7	4.6 x10-6
Visean Limestone Undifferentiated	Lough Corrib Fen 1 (Menlough) Clare-Corrib	5.0 x10-9	3.1 x10-5
Visean Limestone Undifferentiated	Clarinbridge	4.2 x10-7	1.7 x10-6

Plate 10.1: Distribution of calculated hydraulic conductivity



10.3.3.1 The Galway Granite Batholith Aquifer

The GSI descriptions for groundwater bodies in the Galway Granite Batholith such as the Spiddal GWB (GSI 2004a) and the Maam-Clonbur GWB (2004b), describes the aquifer as being a poor aquifer with low storage and short groundwater pathways.

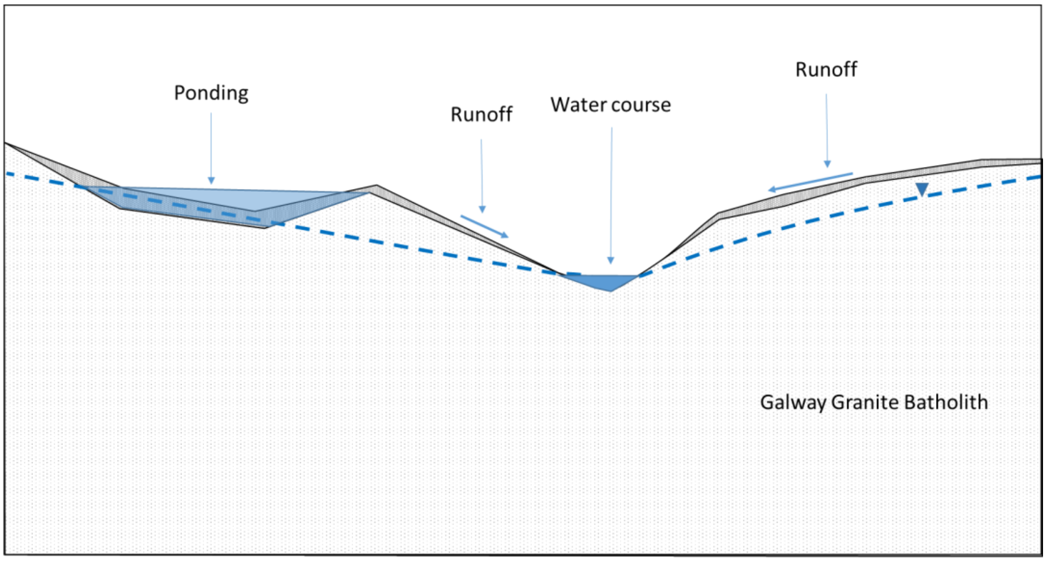
The water level data presented in **Section 10.3.2**, identifies that the groundwater table remains close to the surface and generally follows topography. On this basis groundwater levels will lower towards the coast and the River Corrib. The groundwater divide between the GSI Spiddal GWB and Maam-Clonbur GWB matches the watershed between Galway Bay and the River Corrib, which extends along the high ground at Letteragh and west of Dangan.

The GSI vulnerability data and ground investigation data for the project confirm that subsoil overlying the granite thins on higher ground and is up to 3m thick in low lying ground. The soil and subsoil comprises of glacial tills with high fines content, which is confirmed by particle size distribution (PSD) data that is presented in **Appendix A.9.1**. This data indicates that the permeability or the subsoils is in the low to moderate range (DELG, 1999).

The groundwater level data collected for this project agrees with the GSI division of groundwater bodies and on this basis the extent and naming of these remains unchanged. Based on GSI (2004a and 2004b), groundwater flow in the Galway Granite Batholith is isolated to weathered zones and fracture zones. None of the groundwater level data presented is indicative of high permeability zones.

The Galway Granite Batholith includes areas where there is poor drainage and water ponding at the surface, these areas include the Moycullen Bogs (NHA) and a number of other wetland areas (refer to **Chapter 8 Biodiversity**). The Moycullen Bogs comprise of a main area in the west near Lough Inch and two isolated areas at Tonabrocky and Letteragh (ref **Figure 10.5.002**). Where the surface water ponding occurs there is often little or no seasonal variation in the water level, with most areas remaining ponded throughout the summer.

Plate 10.2: Hydrogeological conceptualisation of runoff and surface water ponding on the Galway Granite Batholith



The undulating topography of the Galway Granite Batholith includes areas of topographic highs where bedrock is near surface and topographic lows where the subsoils are thicker (up to 3m). On the topographic highs rainfall runs off as overland flow whilst it is the lying ground where surface ponding as discussed above tends to occur.

The GSI vulnerability data and the project ground investigation data together with the Ordnance Survey topographic data show that the granite has an undulating rock topography (**Plate 10.2**). As the granite is of low permeability it will perch surface water and where drainage is poor, surface water can be impounded and ponded.

Connectivity between groundwater and the ponded surface water will be slight. As such, the water ponding on the surface at the Moycullen Bogs is not groundwater from the bedrock but water ponded on the top of the bedrock that has saturated the subsoil, has no natural discharge point, so breaches the ground surface.

10.3.3.2 The Visean Undifferentiated Limestone Aquifer

The GSI subdivided the aquifer of the Visean Undifferentiated Limestone into the following groundwater bodies.

- GWDTE Lough Corrib Fen 1 (Menlough)
- GWDTE Lough Corrib Fen 2
- GWDTE Lough Corrib Fen 3 & 4
- Clarinbridge
- Clare-Corrib
- Ross Lake

Each of the groundwater bodies are characterised below and discussed in terms of their interaction with surface water. In all cases the extent of the GWB is reviewed based on the project groundwater monitoring data. In most cases there has been refinement to the extent of groundwater bodies. The GWB retain the names provided by the GSI, however, the prefix of GWDTE is removed from those GWB named so by the GSI.

Ross Lake Groundwater Body

The Ross Lake GWB encompasses the limestone on the western side of the River Corrib. The Ross Lake GWB as mapped by the GSI is presented in **Figure 10.2.002**. The extent of the Ross Lake GWB was revised based upon the ground investigation for the proposed road development and the revised extent is presented in **Figure 10.5.002**.

The GWB receives recharge from rainfall but also runoff from the adjacent granite. There are several drains and ditches that cross from the granite and onto the Ross Lake GWB. As such, the surface catchment for the Ross Lake GWB includes runoff within the local catchment for the River Corrib. As the GWB boundary conditions are physical (i.e. bedrock contact and river) they do not fluctuate seasonally.

GWDTE Lough Corrib Fen 1 (Menlough) Groundwater Body

The GWDTE Lough Corrib Fen 1 (Menlough) GWB extends east from the River Corrib to the townland of Coolough. The eastern extent of the GSI GWDTE Lough Corrib Fen 1 (Menlough) GWB (**Figure 10.5.002**) has been revised westwards to the townland of Coolough to accommodate the groundwater divide identified between it and the Clare-Corrib GWB, which has been refined based on groundwater monitoring for this project.

This GWB has been divided into two areas, namely Lough Corrib Fen 1 Menlough and Lough Corrib Fen 1 Lackagh (note that in the revised mapping of the GWB the term GWDTE has not been used in the GWB title), on the basis of the thick silt and clay subsoils (up to 106m deep) that occur in the townland of Coolough. These thick subsoils deposits, which underlie Coolagh Lakes and form a deep valley fill/palaeokarst feature west of Lackagh Quarry, compartmentalise the GWB so that Lough Corrib Fen 1 (Menlough) lies north of Coolagh Lakes and Lough Corrib Fen 1 (Lackagh) forms a small GWB (<0.04km^2) between Coolagh Lake and Lackagh Quarry. It is noted that Lackagh Quarry lies within the revised Clare-Corrib GWB and not the revised Lough Corrib Fen 1 (Menlough) GWB or Lough Corrib Fen 1 (Lackagh) (**Figure 10.5.002**).

Groundwater flows westwards within the Lough Corrib Fen 1 (Menlough) from the groundwater divide with the Clare-Corrib GWB to the Coolagh Lakes and the River Corrib. Lough Corrib Fen 1 (Menlough) GWB supplies groundwater to Coolagh Lakes via the Western Coolagh Spring (K25). Due to the compartmentalisation of the aquifer by buried valleys/palaeokarst, the groundwater in Lough Corrib Fen 1 (Lackagh) GWB is largely contained. Due to the thick clay subsoil there are no observed discharges from the limestone bedrock to the Eastern Coolagh Spring and the compartmentalisation prevents discharge to Western Coolagh Spring. Instead, groundwater flow from Lough Corrib Fen 1 (Lackagh) is likely to flow eastwards to Lackagh Quarry during peak groundwater levels. There is a potential for seepage from the limestone aquifer through the clayey subsoil to the Eastern Coolagh Spring but due to the low permeability and thickness of the clayey subsoil, these potential seepages are of a very low flow rate. If present, seepages from the subsoil to the Eastern Coolagh Spring would represent a very small fraction of the groundwater contribution to Coolagh Lakes compared to the karst inflow at Western Coolagh Spring (K25), which provides the main groundwater contribution flow to Coolagh Lakes. As described in **Section 10.3.2.3** the Eastern Coolagh Spring (K45) is not a karst spring because it sits on thick clay subsoil as evidenced by ground investigations (GI).

Coolagh Lakes lie in a low-lying area that are shown by GSI data as well as records from 2006 GCOB GI and observations from the site walkover to be underlain by thickness of low permeability overburden and that the overburden adjacent to Upper Coolagh Lake comprises of silt and clay. On this basis, groundwater inflows through the base of the lakes are unlikely and the only significant groundwater input is the karst inflow via the Western Coolagh Spring (K25). Groundwater contribution to Coolagh Lakes from the Eastern Coolagh Spring and any other potential seepages (such as underwater springs from the margin of the Clare-Corrib GWB) are very limited due to the thick clay subsoil that fills the buried valley and forms a very low permeability barrier to the limestone aquifer.

Plates 10.3 and **10.4** below show the interactions between the Coolagh Lakes and Western Coolagh Spring at high and low groundwater levels. During periods of high groundwater levels groundwater contributes flow to the lakes (**Plate 10.3**), while during the summer the groundwater level lowers to just above the lake level and the springs have minimal flow. **Plate 10.4** below, shows the relationship between groundwater levels and surface water levels in the springs that feed Coolagh Upper Lake.

Plate 10.3: Schematic north south cross-section through Coolagh Lakes (groundwater high)

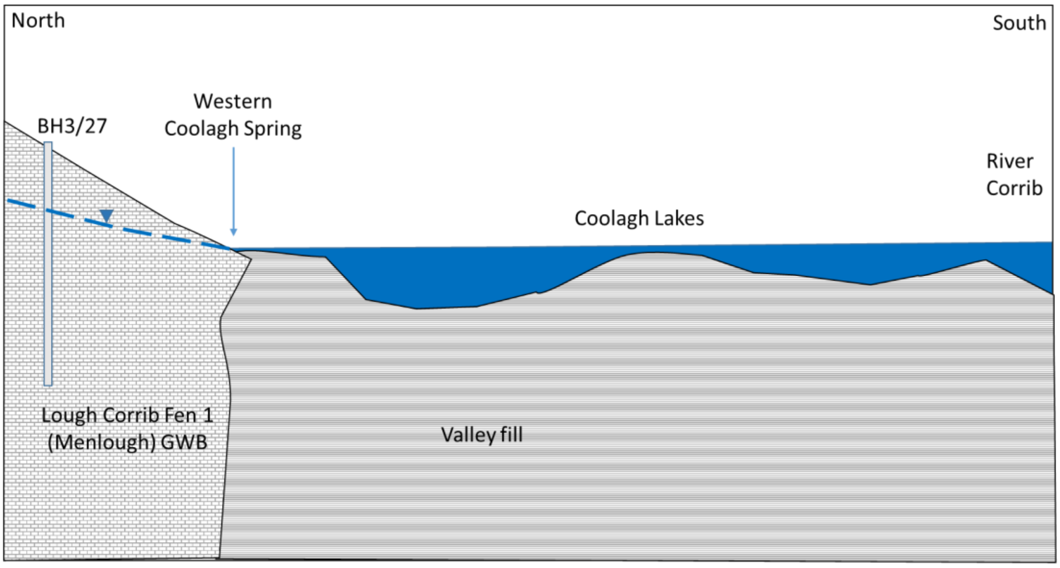
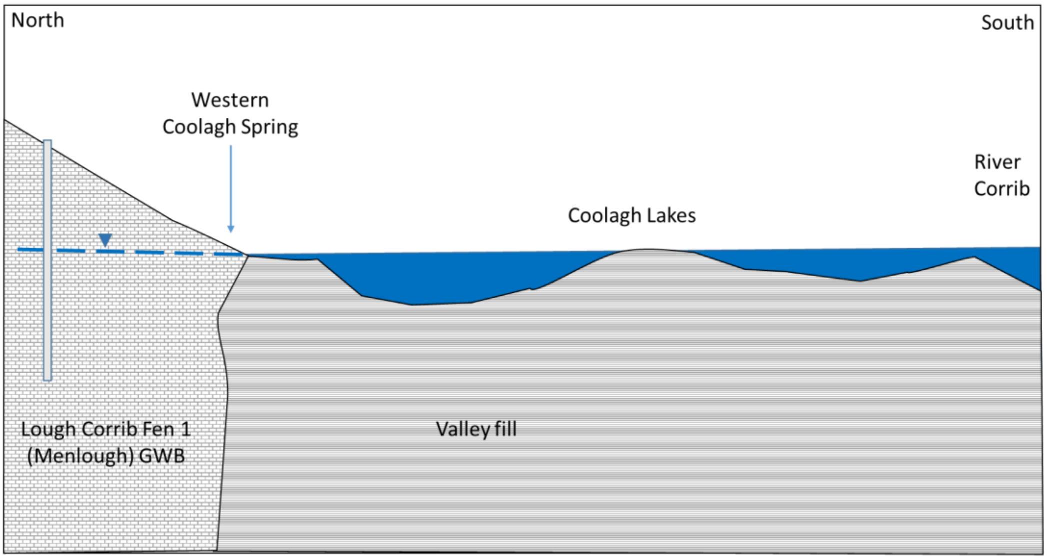
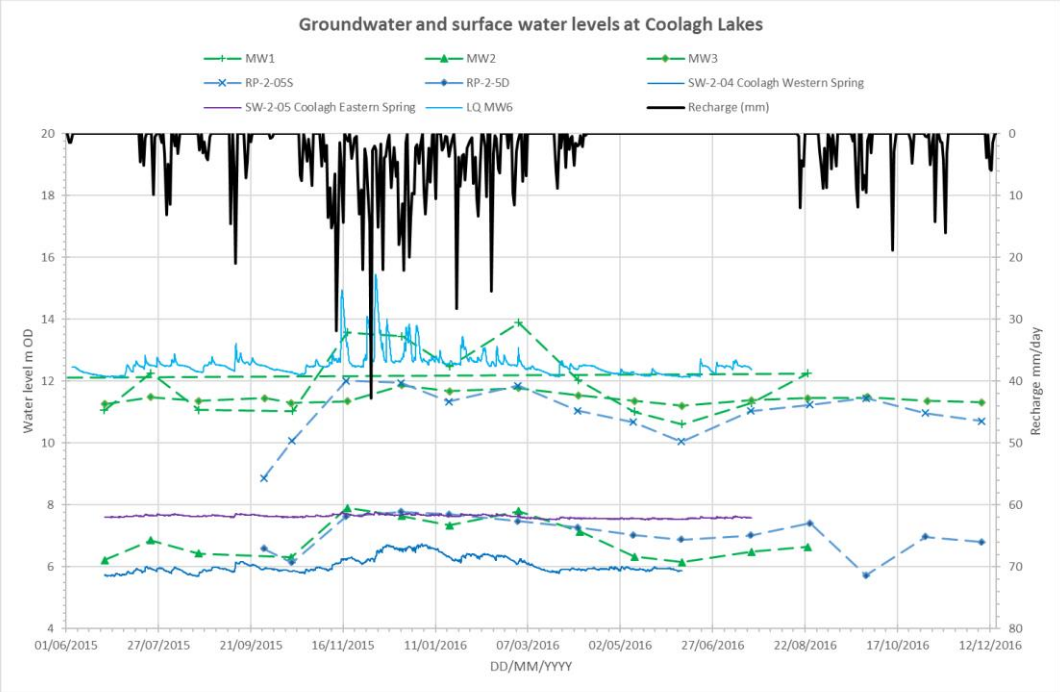


Plate 10.4: Schematic north south cross-section through Coolagh Lakes (groundwater low)



Groundwater hydrographs for the GWB are presented below (**Plate 10.5**), and show the groundwater responses in the aquifer locally as well as levels at the Western Coolagh Spring and Eastern Coolagh Spring.

Plate 10.5: Groundwater and surface water levels at Coolagh Lakes



Western Coolagh Spring is the main water inflow to Coolagh Lakes and has a seasonal variance in water level of 0.7m. Western Coolagh Spring is a karst resurgence in the eastern side of a shallow valley at the head of Upper Coolagh Lake. At this location groundwater flow rises from conduit in limestone bedrock. Flow is turbulent, with flow velocity up to 0.3m/sec (flow of 35l/s) estimated during the winter of 2016. During the summer time the flow at the spring is low (<1l/min). There are a number of seepages associated with Western Coolagh Spring in the western side of the shallow valley. Western Coolagh Spring is the collective of the main spring and the smaller seepages.

Eastern Coolagh Spring is separate from Western Coolagh Spring, being located 850m away in a north eastward direction and 3m higher in elevation. It has a very slight seasonal variable of 0.1m and with no measureable flow. Due to the geological setting of the Eastern Coolagh Spring with clayey subsoil, this feature is not considered is not considered to be a karst feature. As discussed there is potential for seepage from the clayey subsoil inputs to Coolagh Lakes at Eastern Coolagh Spring as well as seepage from elsewhere around the periphery of the lake shore. However, even if seepages are present, the potential seepages rates will be very low when compared to Western Coolagh Spring, even when considering the total seepage flow for the full extent of the lake periphery. This hydrogeological assessment however is based on the precautionary principle and assumes that these seepages occur even though they were not observed.

The extent of the Lough Corrib Fen 1 (Menlough) GWB is shown in **Figure 10.5.002**. The GWB is bound to the west by the River Corrib, to the east by a groundwater divide with the Clare-Corrib GWB, north by a divide with the Lough Corrib Fen 2 GWB and south by thick clayey subsoil deposits on which the Coolagh Lakes have formed.

The Lough Corrib Fen 1 (Lackagh) GWB is relatively small in size ($0.7km^2$) and is also internally subdivided by features such as the thick clayey subsoil deposits that infill the palaeokarst west of Lackagh Quarry. The boundaries, as well as thick subsoil deposits within the GWB, isolate the potential surface catchments for both the Western Coolagh Spring and Eastern Coolagh Spring, and on this basis their catchments can be defined.

The sub catchment for Western Coolagh Spring is defined as the surface area of the Lough Corrib Fen 1 (Menlough) GWB from the eastern GWB boundary (BH4) to the topographic high at MW3. At MW3 there is a small groundwater ridge that allows a divide between groundwater that flows to Western Coolagh Spring and groundwater that flows the River Corrib. As MW3 lies 200m east of the River Corrib the extent of the groundwater sub catchment that drains to the River Corrib is limited to the 200m wide strip adjacent to the river (less than $0.1km^2$).

The pond at Eastern Coolagh Spring has the potential to receive seepage from the subsoil surrounding the feature. The extent of the catchment is restricted to the area in the valley floor. Any groundwater flow from the limestone aquifer to the Eastern Coolagh Spring would have to seep through the clayey subsoil and hence be of a very low quantity.

The groundwater levels in the GWB (**Plate 10.5**) show that as well as having the largest sub-catchment in the Lough Corrib Fen 1 GWB, the Western Coolagh Spring is also the lowest measured point of the groundwater table. On this basis the Western Coolagh Spring (as well as Coolagh Lakes and River Corrib) is the main receiving water. Based on the descriptions presented, the Western Coolagh Spring is considered to be the sole significant groundwater contributor to Coolagh Lakes.

The western boundary of the Lough Corrib Fen 1 (Menlough) GWB is physically bound by a river. The seasonal variance is very slight due to the level of the river. However, the eastern boundary of the Lough Corrib Fen 1 (Menlough) GWB is a groundwater divide and the seasonal fluctuation in groundwater levels has the potential to cause the divide to shift laterally.

Due to the compartmentalisation of the Lough Corrib Fen 1 (Lackagh) GWB, flow is prevented from draining to Western Coolagh Spring and only small scale seepage via the clayey subsoil is possible at the Eastern Coolagh Spring. The compartmentalisation of the aquifer means that during peak levels the groundwater in the Lough Corrib Fen 1 (Lackagh) may flow eastwards towards Lackagh Quarry.

Based on the maximum and minimum groundwater levels data presented in **Table 10.8** and **Figure 10.6.107** to **Figure 10.6.110** the groundwater divide occurs at near BH4 during the winter. During the summer the groundwater table gradient flattens and the divide migrates north westwards by an estimated 250m (based on the seasonal groundwater level data for BH4 and LQMW4, refer to **Appendix 10.3**).

On the basis of the above descriptions, the Lough Corrib Fen 1 (Menlough) GWB is the sole significant groundwater contributor (via Western Coolagh Spring (K25)) to Coolagh Lakes. The Coolagh Lakes discharge to the River Corrib, both of which are part of the Lough Corrib cSAC and therefore the Lough Corrib Fen 1 (Menlough GWB contributes to this cSAC. As the River Corrib discharges into Galway Bay this GWB also contributes (indirectly) to Galway Bay Complex cSAC and Inner Galway Bay SPA.

GWDTE Lough Corrib Fen 2 Groundwater Body

The GSI mapping of the extents of GWDTE Lough Corrib Fen 2 is shown in **Figure 10.2.002**. Based on the groundwater level data collected for the proposed road development the southern boundary of the GWB as per GSI is set 0.3km too far south. Based on the water level data for the proposed road development the GWB extent has been updated and is shown in **Figure 10.5.002**. Note that in the revised mapping of the GWB the term GWDTE has not been used in the title.

Although the proposed road development does not extend into this GWB (**Figure 10.5.002**) the divide between the GWB and the adjacent GWDTE Lough Corrib Fen 1 GWB lies in close proximity to it. On this basis this GWB is considered as one of the GWB traversed by the proposed road development.

The seasonal fluctuation in the GWB as 2.5m, as recorded in monitoring well RC133, which is located close to the groundwater divide (**Table 10.8**). Based upon slight seasonal variation and relatively low hydraulic gradients in the area the groundwater divide is considered to be stable and not fluctuate laterally.

Lough Corrib Fen 2 GWB contributes to Lough Corrib. The only surface water recorded in the GWB is Turlough K20 and spring K17.

GWDTE Lough Corrib Fen 3 and 4 Groundwater Body

Based on groundwater level data collected for the proposed road development, the southern extent of the GSI Lough Corrib Fen 3 and 4 GWB has been reduced and been moved north by over 2km. The revised groundwater bodies are presented in **Figure 10.5.002**, although it is noted that based on the revised extent, this GWB no longer extends onto the figure. Note that in the revised mapping of the GWB the term GWDTE has not been used in the title.

Clare-Corrib Groundwater Body

The GSI mapping of the GWB is shown in **Figure 10.2.002**. Based on the groundwater level data collected for the proposed road development, the extent of the Clare-Corrib GWB has been revised with the GWB extended further west, as far as the townland of Coolough, near Menlough, and further east to the N83 Tuam Road (**Figure 10.5.002**).

There are a number of features in the GWB that have ponded water and these have the potential to interact with groundwater. These pond features include Ballindooley Lough (which comprises of the main Ballindooley Lough and a number of smaller surface water bodies immediately to the south), a small surface water body at Ballinfoyle, an enclosed depression referred to as K97 in the karst survey (refer to **Appendix 10.2**), and the Terryland River, including adjacent ecology have been identified in the **Chapter 8, Biodiversity** as being potential water dependant habitats. The hydrogeological aspects of these features are presented below.

Ballindooley Lough

Geophysics undertaken south of Ballindooley Lough for this project and north of the Ballindooley Lough for 2006 GCOB indicate that thick subsoils underlie the extents of Ballindooley Lough. From this data it is inferred that a feature, such as a buried valley, underlies the length of the lake. The subsoils below the lake explain the permanent perching of the surface water level when groundwater levels are low.

The groundwater data shows that Ballindooley Lough lies up gradient of the proposed road development. The data also shows the lough to be perched during the summer when groundwater levels (RP-2-01 & RC1104) drop below the lake water level (**Plate 10.6** and **10.7**). On this basis, during low groundwater levels the perched water in Ballindooley Lough and the groundwater in the limestone aquifer form separate and distinct water bodies.

Plate 10.6: Schematic east west cross-section through Ballindooley Lough showing the interaction of groundwater with the lake during high groundwater levels

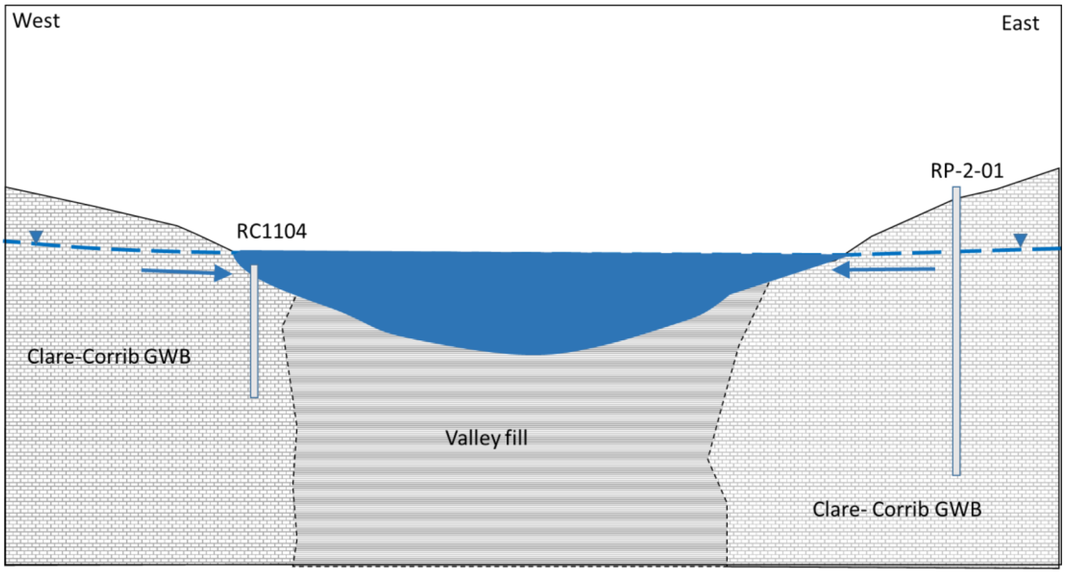
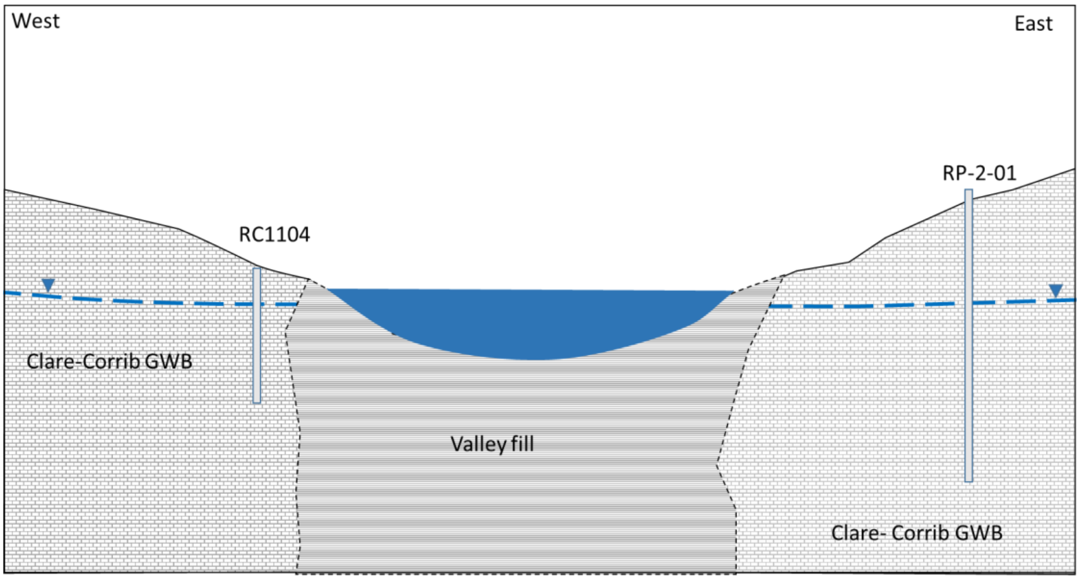


Plate 10.7: Schematic east west cross-section through Ballindooley Lough showing the interaction of groundwater with the lake during low groundwater levels



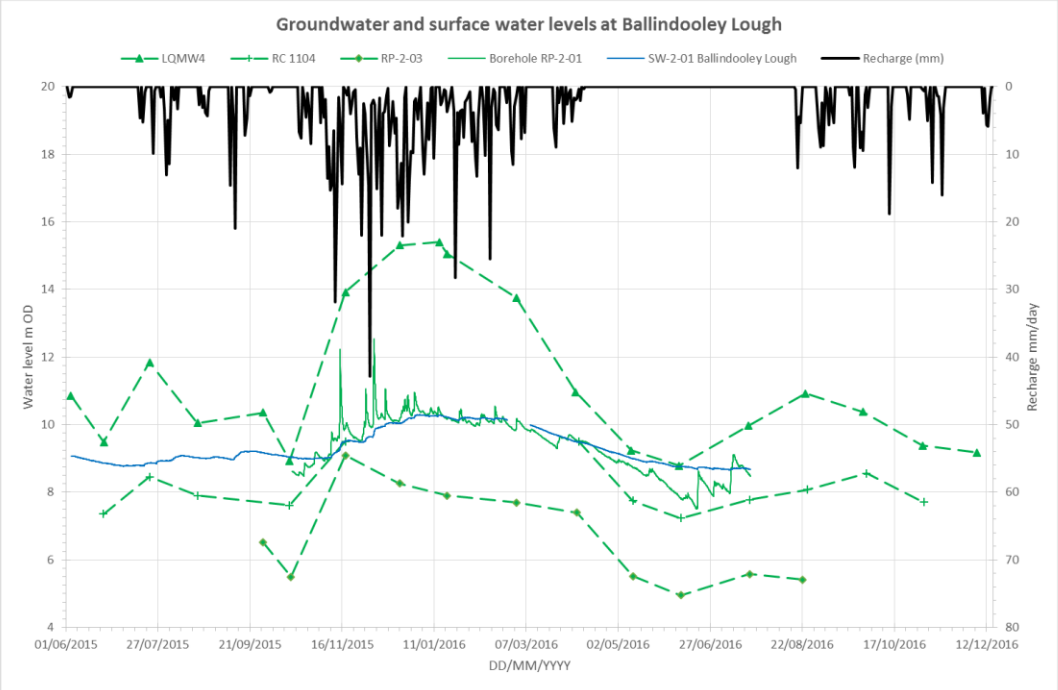
During the winter, the lake level in Ballindooley Lough and the groundwater level in the limestone aquifer are in continuity. On this basis, Ballindooley Lough only receives groundwater during high groundwater levels.

Bathymetry of Ballindooley Lough shows that the lake has a max depth of 10m (-2.5m OD). Based on the geophysics data and the analyses that the summer lake water level is distinct from groundwater, then the base of summer water level in Ballindooley Lough lies on low permeability subsoil and not limestone.

The hydrographs for the GWB below in **Plate 10.8** show that the groundwater level in wells surrounding Ballindooley Lough are continuous with the level of Ballindooley Lough during the winter. However, in the summer the groundwater level lowers below the permanent water level of the lough perching it.

Also notable are the groundwater levels in monitoring well RP-2-03 located 300m south of Ballindooley Lough (**Figure 10.6.009**) are significantly lower than other groundwater levels in the area and the surface water level at Ballindooley Lough. The lower water table in RP-2-03 indicates the direction of flow southwards within the groundwater body.

Plate 10.8: Groundwater and surface water levels at Ballindooley Lough



Enclosed depression (Doline) K97

Doline K97 was identified by the karst survey. It is a c.40m circular enclosed depression, with soft clay in the base, that is located near Castlegar (**Figure 10.1.002**). This doline is included in this assessment as it was originally highlighted as potentially being a turlough, however as outlined below and in **Chapter 8, Biodiversity** it has since been confirmed as not meeting either the ecological or hydrogeological criteria for a turlough.

Based on the above groundwater levels it is clear that there is a distinct difference in groundwater level to the west (Monitoring well BH3/34) and to the east (monitoring well RC-2-01 & RC-2-03) (Refer to **Plate 10.9** and **Plate 10.10**).

The ground investigation data shows that the feature K97 is located within thick subsoil. BH3/32 shows silt and clay subsoil to 23m below ground level (bgl) and geophysics GP3/32 (ERT) (**Appendix 9.1**) shows low resistivity material to a depth of greater than 20m. However, to the east of the site BH3/33 (no piezometer) and geophysics GP3/13 show bedrock to be with 3m of the surface.

Plate 10.9: Schematic east west cross-section through enclosed depression K97 showing the interaction of groundwater with the feature during high groundwater levels

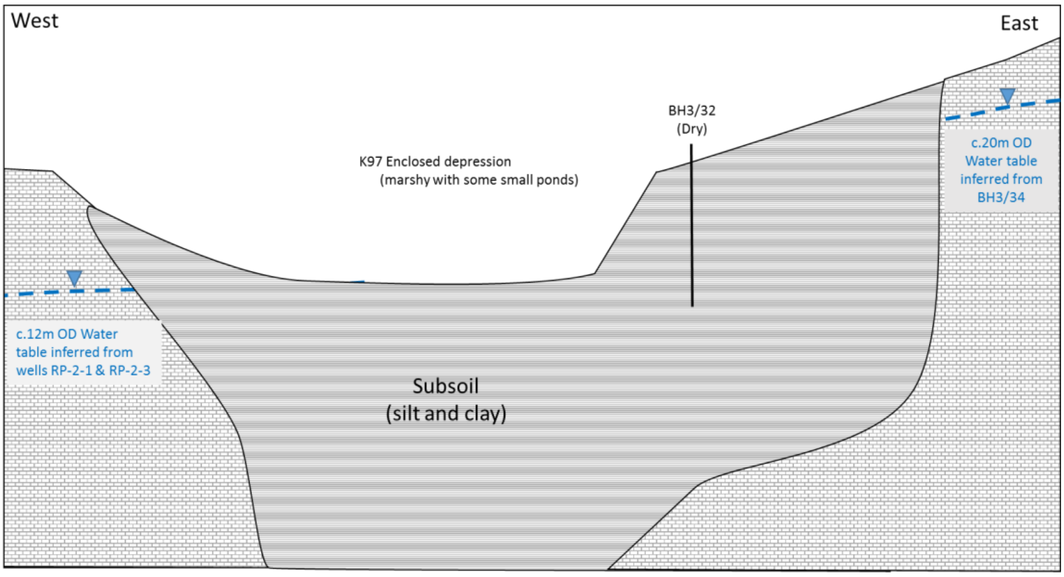
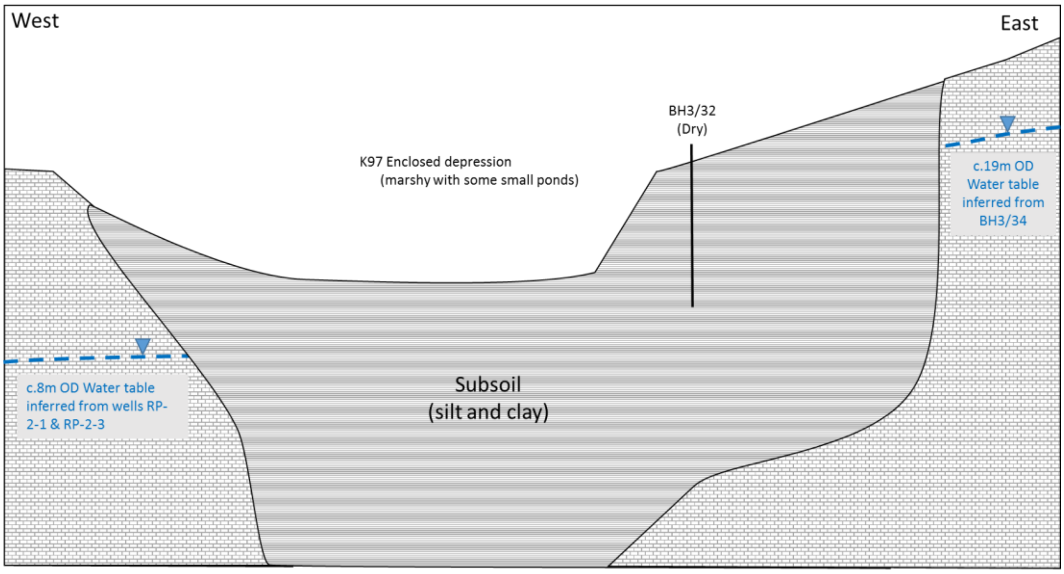


Plate 10.10: Schematic east west cross-section through enclosed depression K97 showing the interaction of groundwater with the feature during low groundwater levels



Due to the low permeability nature of the subsoils it is very unlikely that there is a groundwater contribution to the base of the depression. Water ponding in the base is likely to be entirely due to incident rainfall, captured by the depression. The hydrogeological descriptions provided strongly indicate that the feature does not receive groundwater.

<u>Surface water at Ballinfoyle</u>

The surface water feature at Ballinfoyle (N97) lies in the valley floor approximately 600m southwest of Ballindooley Lough, adjacent to and immediately east of the N84 Headford Road at Ballinfoyle (**Figure 10.1.002**). The feature is square in shape measures with 80m long sides and is located within silt/clay subsoils.

It is a seasonal lake that fills during the autumn and drains during spring. Groundwater levels on the north-western side (monitoring wells LQMW1-4) rise above the feature's floor and cause it to flood during the winter. Notably the groundwater level on the south-eastern side remains below the feature's floor at all times (monitoring well RP-2-03). The disparity in groundwater levels across the feature (refer to **Plate 10.11** and **Plate 10.12**) indicates a barrier to groundwater flow and based on the location along the trend of the valley at Ballindooley it is likely that this feature is located on thick clay subsoil.

Based on the groundwater level data, this feature receives groundwater from the bedrock aquifer to the northwest during the winter. The ponding occurs in the feature due to the subsoil deposits that underlie the feature. As the feature is not located on limestone the feature does not have the hydrogeological characteristics of a turlough and is surface water ponding.

Plate 10.11: Schematic east west cross-section through Feature (N97) showing the interaction of groundwater with the feature during high groundwater levels

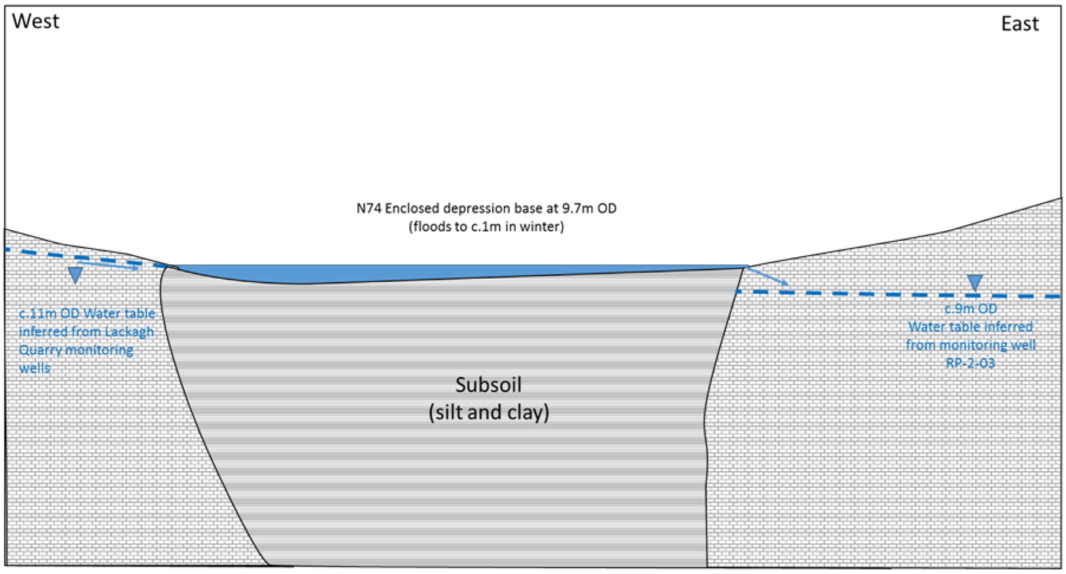
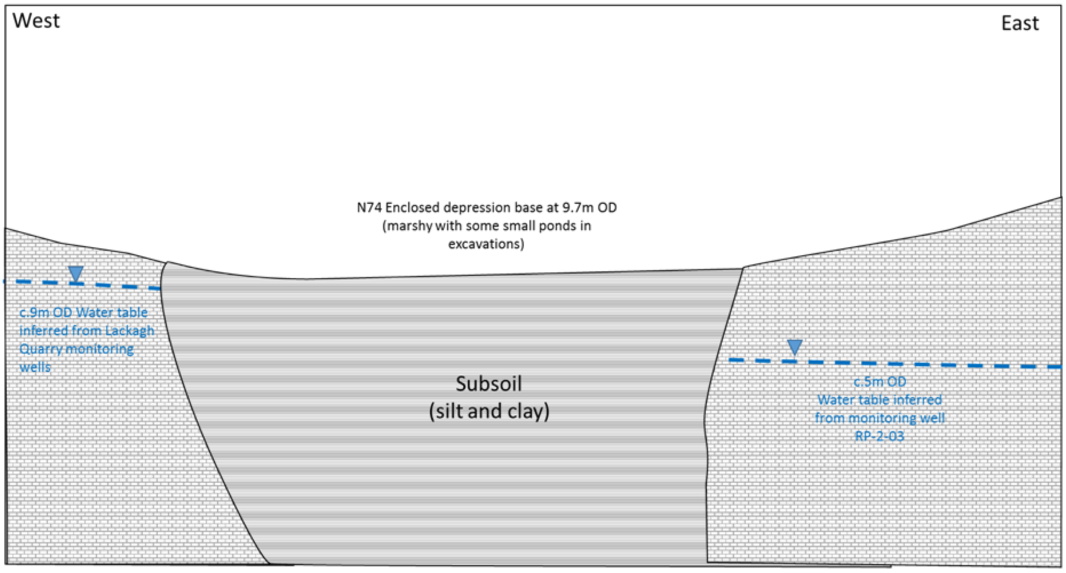


Plate 10.12: Schematic east west cross-section through Feature (N97) showing the interaction of groundwater with the feature during low groundwater levels



Terryland River

Under normal conditions the Terryland River sinks at two stream sinks, named Pollavurleen West and East (K87 and K96) near Glenanail (Refer to karst study in **Appendix A.10.2**) (**Plate 10.13**). However, during high groundwater levels, the Terryland sinks become resurgences and discharge groundwater to the Terryland River that flows back and joins the River Corrib (**Plate 10.14**).

The switching between sink to resurgence makes these estavelles. Whilst the sinks are located near limestone outcrop, the Terryland River flows for its length along a low-lying area that has thick overburden. The low permeability of the subsoil here carries the surface water across the valley until the limestone is met at the southern side of the valley.

Plate 10.13: Schematic north south cross-section through Terryland River showing the operation of the estavelles at Pollavurleen West and East during high groundwater levels

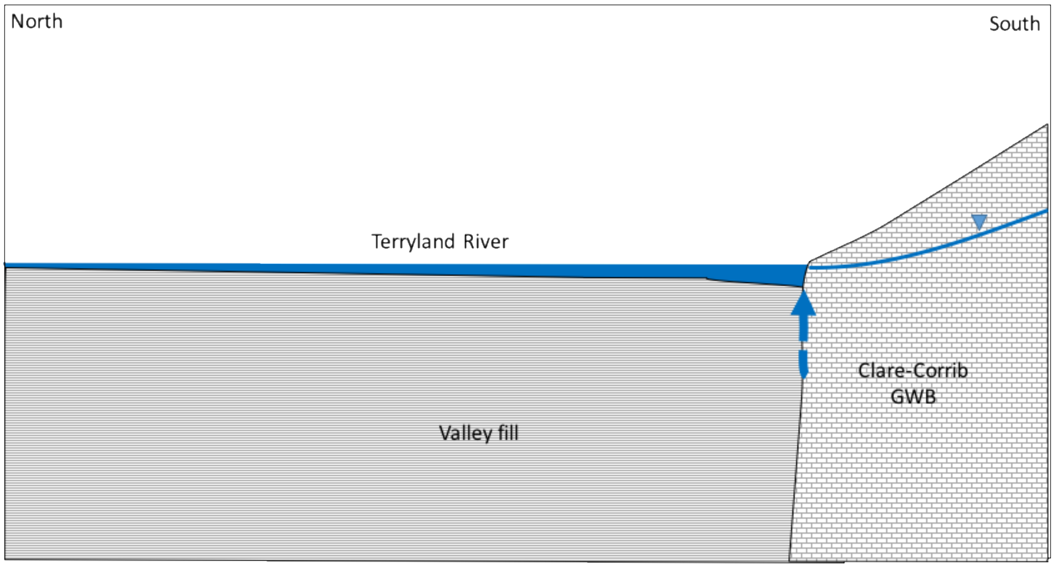
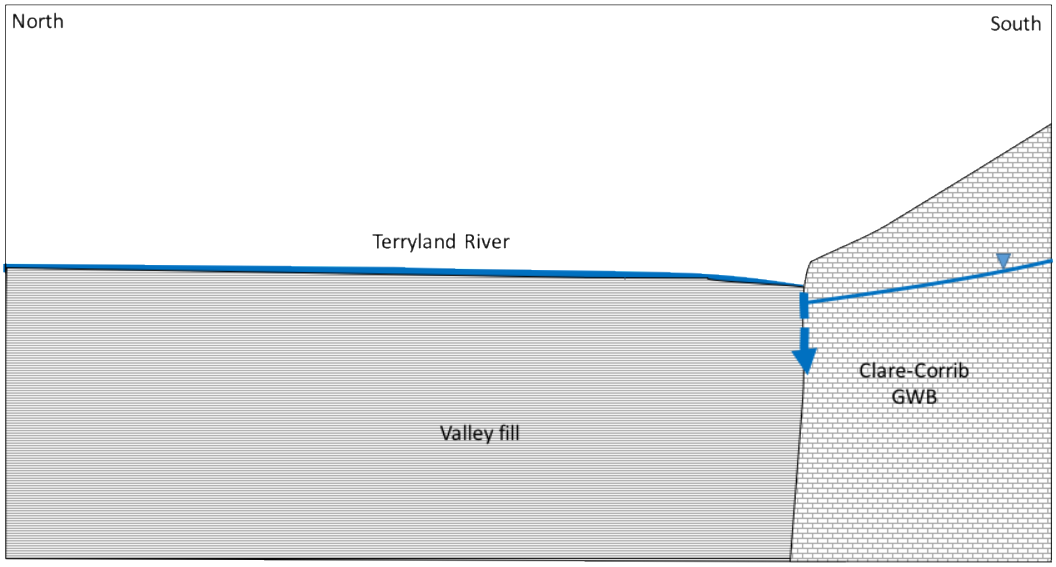


Plate 10.14: Schematic north south cross-section through Terryland River showing the operation of the estavelles at Pollavurleen West and East during low groundwater levels



There are a number of Annex 1 habit that occur in the valley of the Terryland River on the thick subsoil deposits. As these features are not located on bedrock but on the thick subsoil, these features are dependent on pluvial flooding and are not groundwater dependent.

Clarinbridge Groundwater Body

The Clarinbridge GWB as delineated by the GSI is a large groundwater body that extends from Galway City eastwards past Galway Airport to Athenry and then south from Athenry to Clarinbridge and as far south as Ardrahan. As the Clarinbridge GWB extends over a number of rivers and streams it can be subdivided into several smaller groundwater bodies that are distinct and isolated from each other. One of these smaller sub-catchments of the Clarinbridge GWB is the area of the higher ground between Galway Airport and Ballybrit.

The divide between the Clarinbridge GWB and the Clare-Corrib GWB is marked by the thick overburden deposits along the line of the N83 Tuam Road. These thick low permeability superficial deposits have been proven to a minimum depth of 30m. Conceptually these thick low permeability deposits form a hydraulic barrier between the Clare-Corrib and Clarinbridge groundwater bodies.

The groundwater level monitoring data collected in the Clarinbridge GWB for the proposed road development has a shallow water table relative to the rest of the study area. The shallow groundwater table is generally within 4m of the surface and follows topography, lowering gradually southwards towards Galway Bay. The seasonal fluctuation in the aquifer is of the order of 2m. The characteristics of the Visean Limestone Undifferentiated in the GWB indicate lower aquifer properties, with fracture flow and only small scale surface karst landforms present.

10.3.4 Groundwater Receptors

There are a number of receptors within the study area which are connected to or dependent upon groundwater to maintain their hydrogeology. The types of receptors that could be affected by the proposed road development are:

- Groundwater resources and abstractions
- Groundwater dependent habitats
- Groundwater dependent surface water features

The individual receptors identified under these headings are described below and an outline of the receiving environment for each is provided. Based on the conceptual model outlined in **Section 10.3.3**, a number of these will not be affected by the proposed road development and a full impact assessment will not be required. These are clearly identified and those which do require an impact assessment are assessed in full in **Section 10.5**.

The importance of these groundwater receptors is ranked according to TII Guidelines on the attribute classification criteria presented in **Table 10.1**. Potential hydrogeological impacts are defined as any negative changes to the baseline groundwater quantity and / or groundwater quality.

10.3.4.1 Groundwater Resources

As outlined in **Section 10.3.1** and presented on **Figure 10.1.001**, the west of the study area, the aquifer is classified as a Pl aquifer and in the east of the study area, the aquifer is classified as a Rkc aquifer. These aquifers have an importance ranking of Low and Extremely High respectively in line with TII importance ranking criteria presented in **Table 10.1**.

10.3.4.2 Groundwater Supplies

Water Supplies refer to any large springs, groundwater abstractions for local authorities, commercial / industrial, holy wells, Group Water Schemes or private well supplies.

Source Protection Plans have been published by the GSI or EPA to define the groundwater catchment for some large public water supplies and state appropriate land use practices within the catchment. The Source Protection Areas include Inner and Outer Protection areas. There are no Source Protection Areas within the study area for the proposed road development.

Figures 10.5.002 shows the locations of all wells recorded by the GSI. However, as it is not a requirement for wells to be registered with the GSI the GSI list of wells is not necessarily complete. Local authority and National Federation of Group Water Schemes (NFGWS) records were also consulted to determine the locations of groundwater abstractions.

During consultations with landowners they were asked if they had a private well supply and this information has been incorporated into this assessment (refer to **Section 10.2.5**). Where no information is available on the construction or abstraction details of these private well supplies, a conservative approach has been undertaken (i.e. the assumption has been made that they are shallow wells so more vulnerable to pollution).

The GSI database identifies one major groundwater abstraction in the Galway Granite Batholith at Knocknacarra (W50-01) which is a group water scheme that supplies approximately 50 houses. The GSI database also lists one private supply well (W50-09) and one spring supply (W1000-01). The site walkover and consultations with landowners has not identified any additional wells in the Galway Granite Batholith.

Based on TII importance ranking criteria, the importance ranking for the major abstraction at Knocknacarra (WS50-01) is ranked as Medium and the well (W50-09) and spring (W1000-01) are ranked as Low. All of the groundwater supplies identified in the Galway Granite Batholith are within 1km beyond the study area extent and are identified as part of the desk study. These groundwater abstractions are included in the assessment as a conservative measure to ensure that the catchments for each well is appropriately assessed.

The Visean Undifferentiated Limestone has four large groundwater abstractions within the study area, these comprising of one commercial groundwater abstraction (W50-12) on the N84 Headford Road and three groundwater abstractions for Galway Racecourse (W50-13, 14 and 15).

W50-12 is an industrial supply well for a commercial water bottling facility and has an abstraction rate of approximately 250m^3/day. TII criteria only applies to domestic wells, however for this assessment commercial supplies are considered equal to domestic supplies with the average metered (residence) water consumption ranging between 274 to 383 litres per day (Central Statistics Office, 2015[3]). On this basis, W50-12 has an equivalent supply of up to 1,000 houses and is ranked as having an importance ranking of 'High'.

Galway Racecourse wells W50-13 and W50-14 provide a cumulative 2,000m^3/day of groundwater that is primarily for use for watering of the track but is also used to supply drinking water for the horses and water to wash down the yard. The cumulative abstraction of W50-13 and W50-14 has a combined equivalent of >2,500 houses and a 'Very High' importance.

Galway Racecourse well W50-15 abstracts 380m^3/day for potable use. Based on TII criteria for domestic wells W50-15 has an equivalent of 1,400 houses and is ranked as having a 'High' importance.

The Visean Undifferentiated Limestone is tapped into for 20 private domestic wells. These comprise of W50-02, 03, 04, 05, 06, 07, 08, 10 and 11, W100-01,02,03, 04, 05 and 06, W500-1 and W1000-02, 03 and 04.

One geothermal well has been identified (G50-01), which located on Ballybrit Crescent. The geothermal well is of a closed loop design developed within the Visean Undifferentiated. Consultation with the landowner identified that the well relies on an open borehole design, which uses the thermal conductance of the groundwater from the bedrock to heat the closed loop piping.

Based on TII importance ranking criteria, domestic abstraction wells have an importance ranking of 'Low'. Domestic closed loop geothermal wells are assessed as being comparable to domestic abstraction wells and also have an importance ranking of 'Low'.

10.3.4.3 Groundwater dependant Habitats

A full review of ecological features and designated ecological sites in the study area are detailed in **Chapter 8, Biodiversity**. The habitats listed in this section are those identified in **Chapter 8, Biodiversity** as being water dependant. Those habitats dependent on hydrogeological characteristics include groundwater dependant terrestrial ecosystems (GWTDE) receptors that are dependent on emergent groundwater but also features such as limestone pavement and associated ecosystems, which are dependent on well drained karst bedrock.

European sites comprise of (candidate) Special Areas of Conservation ((c)SAC) and Special Protection Areas (SPA), whilst National sites comprise of National Heritage Areas (NHA) and potential Heritage Areas (pNHA). As detailed in TII Guidelines, those sites that are designated as European sites status are ranked of

[3] Central Statistics Office. Statistical Release 25 April 2017. Domestic Metered Public Water Consumption.

international importance whilst those designated as National sites are ranked of national importance.

Habitats outside of European and National sites are ranked dependent on hydrogeological characteristics. Annex 1 habitats are attributed as ‘Very High’ owing to their national importance.

European sites

This section identifies those European sites that have the potential to be impacted from a hydrological perspective. All European sites within 30km of the proposed road development have been considered using the precautionary principle. The European sites beyond 15km do not have a groundwater connection from the proposed road development and are not considered further.

The screening of all European sites within 15km of the proposed road development is presented below in **Table 10.11**. Those European sites that are located in separate and distinct groundwater bodies or sub catchments are not considered further as there is no groundwater connection from the proposed road development.

Table 10.11: Screening of European sites by proximity to the proposed road development

Site Name	Proximity to Proposed Road Development	Screening	Result
Black Head-Poulsallagh Complex cSAC	11km	Site lies in separate groundwater body	Not considered further
Moneen Mountain cSAC	13km	Site lies in separate groundwater body	Not considered further
Castletaylor Complex cSAC	14km	Site lies in separate groundwater body	Not considered further
Galway Bay Complex cSAC	0.2km	Site lies adjacent to groundwater body that the proposed road development traverses	Impact assessment required
Lough Corrib cSAC	0km	Site lies adjacent to groundwater body that the proposed road development traverse	Impact assessment required
Rahasane Turlough cSAC	13km	Site lies in separate groundwater body sub catchment	Not considered further
Lough Fingall Complex cSAC	11km	Site lies in separate groundwater body sub catchment	Not considered further
Gortnandarragh Limestone Pavement cSAC	14km	Site lies in separate groundwater body sub catchment	Not considered further

Site Name	Proximity to Proposed Road Development	Screening	Result
Kiltiernan Turlough cSAC	14km	Site lies in separate groundwater body sub catchment	Not considered further
Ross Lake and Woods cSAC	10km	Site lies in separate groundwater body sub catchment	Not considered further
East Burren Complex cSAC	13km	Site lies in separate groundwater body	Not considered further
Connemara Bog Complex cSAC	6km	Site lies in separate groundwater body	Not considered further
Ardrahan Grassland cSAC	15km	Site lies in separate groundwater body sub catchment	Not considered further
Inner Galway Bay SPA	1km	Site lies adjacent to groundwater body that the proposed road development traverses	Impact assessment required
Lough Corrib SPA	0.1km	Site lies adjacent to groundwater body that the proposed road development traverses	Impact assessment required
Rahasane Turlough SPA	13km	Site lies in separate groundwater body sub catchment	Not considered further
Cregganna Marsh SPA	4km	Site lies in separate groundwater body sub catchment	Not considered further
Connemara Bog Complex SPA	9km	Site lies in separate groundwater body	Not considered further

Based on the above regional screening there are four European sites that are either located within or receiving groundwater from catchments that the proposed road development traverses (**Figure 10.5.002**). These are:

- Lough Corrib cSAC
- Lough Corrib SPA
- Galway Bay Complex cSAC
- Inner Galway Bay SPA

Ballindooley Lough is identified in **Chapter 8, Biodiversity** as supporting the wintering birds of the Lough Corrib SPA and Inner Galway Bay SPA. On this basis Ballindooley Lough is included in the assessment under the heading of European sites.

Lough Corrib cSAC, Lough Corrib SPA, Galway Bay Complex cSAC and Inner Galway Bay SPA receive groundwater from the Galway Granite Batholith and the Visean Undifferentiated Limestone that the proposed road development traverse. The supporting site, Ballindooley Lough, only receives groundwater from the Visean Undifferentiated Limestone. A breakdown of the contributions from groundwater bodies traversed by the proposed road development to these European sites (including supporting sites) are summarised below in **Table 10.12**.

Table 10.12: Groundwater bodies traversed by the proposed road development and the European sites they potentially contribute to

Groundwater Body	Lough Corrib cSAC	Lough Corrib SPA	Galway Bay Complex cSAC	Inner Galway Bay SPA	Ballindooley Lough
Spiddal GWB	-	-	Contributes	Contributes	-
Maam Clonbur GWB	Contributes	Contributes	Contributes	Contributes	-
Ross Lake GWB	Contributes	Contributes	Contributes	Contributes	-
Lough Corrib Fen 1 (Menlough) GWB and Lough Corrib Fen 1 (Lackagh) GWB	Contributes	-	Contributes	Contributes	-
GWDTE Lough Corrib Fen 2	Contributes	Contributes	Contributes	Contributes	-
Clare-Corrib	Contributes	Contributes	Contributes	Contributes	Contributes
Clarinbridge	-	-	Contributes	Contributes	-

Based on the hydrogeological characterisation (**Section 10.3.3**) the Visean Undifferentiated Limestone contributes a greater component of groundwater to the River Corrib than the Galway Granite Batholith.

The Visean Undifferentiated Limestone includes a number of karst point discharges to the Lough Corrib cSAC, which include the Western Coolagh Spring and Terryland River (during high groundwater flow). These karst point discharges provide significant contribution to habitat in the Lough Corrib cSAC.

Each of these European sites has a ranking of ‘Extremely High’ importance in line with TII Guidelines. Potential impacts to these European sites from the characteristics of the proposed road development are evaluated in **Section 10.5**.

National Heritage Area (NHA)

This section identifies those National sites (both National Heritage Areas and proposed National Heritage Areas) that have the potential to be impacted from a hydrological perspective. All National sites within 30km of the proposed road development have been considered using the precautionary principle. The National sites beyond 15km do not have a groundwater connection from the proposed road development and are not considered further.

The screening of all National sites within 15km of the proposed road development is presented below in **Table 10.13**. Those National sites that are located in separate and distinct groundwater bodies or sub catchments are not considered further as there is no groundwater connection from the proposed road development.

Table 10.13: Screening of National Heritage Areas (NHA) and proposed National Heritage Areas (pNHA) by proximity to the proposed road development

Site Name	Proximity to the proposed road development	Screening	Result
Ross Lake and Woods pNHA	11km	Site lies in separate groundwater body sub catchment	Not considered further
Moycullen Bogs NHA (Lough Inch / Na Foraí Maola Thair, Tonabrocky and Letteragh)	0km	Lough Inch / Na Foraí Maola Thair lies within 250m Tonabrocky lies at 250m Letteragh lies adjacent	Impact assessment required for all three locations
Furbogh Woods pNHA	2km	Site lies beyond 250m but within groundwater body traversed by proposed road development	Impact assessment required
Gortnandarragh Limestone Pavement pNHA	14km	Site lies in separate groundwater body	Not considered further
Drimcong Wood pNHA	8km	Site lie in separate groundwater body	Not considered further
Killarainy Lodge, Moycullen pNHA	8km	Site lies in separate groundwater body	Not considered further
Ballycuirke Lough pNHA	5km	Site lies in separate groundwater body	Not considered further
Lough Corrib pNHA	0km	Site lies adjacent at the Corrib crossing	Impact assessment required
Kiltullagh Turlough pNHA	2km	Site lies within same groundwater body sub catchment	Impact assessment required
Cregganna Marsh NHA	4km	Site lies in separate groundwater body sub catchment	Not considered further

Site Name	Proximity to the proposed road development	Screening	Result
Galway Bay Complex NHA	0.2km	Site lies adjacent to groundwater body traversed by proposed road development	Impact assessment required
East Burren Complex pNHA	14km	Site lies in separate groundwater body	Not considered further
Rahasane Turlough pNHA	14km	Site lies in separate groundwater body sub catchment	Not considered further
Lough Fingal Complex pNHA	11km	Site lies in separate groundwater body	Not considered further
Castletaylor Complex pNHA	14km	Site lies in separate groundwater body sub catchment	Not considered further
Kiltiernan Turlough pNHA	14km	Site lies in separate groundwater body sub catchment	Not considered further
Ballyvaughn Turlough pNHA	15km	Site lies in separate groundwater body	Not considered further
Blackhead Poulsallagh Complex pNHA	11km	Site lies in separate groundwater body	Not considered further

Based on the above regional screening there is one NHA site and four pNHA sites that have the potential to be impacted by the proposed road development. These are:

- Moycullen Bogs NHA
- Furbogh Woods pNHA
- Kiltullagh Turlough pNHA
- Galway Bay Complex pNHA
- Lough Corrib pNHA

The Moycullen Bogs NHA, which are located on the Galway Granite Batholith, occur as one main site encompassing west of Lough Inch and two isolated sites one at Letteragh and one at Tonabrocky. The southern corner of the main site lies within 250m of the proposed road development, whilst the site at Letteragh lies adjacent to the proposed road development. The site at Tonabrocky lies 250m away from the footprint of proposed road development.

The Moycullen Bogs include areas of surface water ponding, which is present at all sites. Based on the conceptual site model for the Galway Granite Batholith (**Section 10.3.3**) the surface water ponding is caused by the low aquifer properties of the underlying granite, which causes water infiltrating through the subsoil to perch above the undulating rock head.

These surface ponds are not dependant on groundwater per se but they are dependent on the site specific hydrogeology, specifically the low aquifer properties, the undulating nature of the rock head and also rainfall. The Moycullen Bogs are ranked as having a 'Very High' importance based on the TII guidance and are assessed in the evaluation of impacts (**Section 10.5**).

Furbogh Woods pNHA area located at the coast within the Spiddal GWB approximately 2km west of the proposed road development. Groundwater flow within the Spiddal GWB follows surface water patterns and may be divided into sub catchments on the basis of surface water streams. On this basis the Furbogh Woods pNHA lies in a separate sub catchment to the proposed road development, and is not considered further in this assessment.

Kiltullagh Turlough pNHA lies near Galway Airport, 2.5km east of the proposed road development. The turlough lies within the Clarinbridge GWB at an elevation of approximately 10m OD. Based on the groundwater levels recorded for the environmental studies for the proposed road development (refer to **Section 10.3.2**) the groundwater flow direction is southwards towards Galway Bay. On this basis, although Kiltullagh Turlough NHA is topographically low, it is located 2.5km upgradient of the proposed road development and is not considered further.

Lough Corrib NHA and Galway Bay Complex NHA receive groundwater from the Galway Granite Batholith and the Visean Undifferentiated Limestone that the proposed road development traverse. Both the Lough Corrib NHA and Galway Bay Complex NHA has a ranking of 'Very High' importance in line with TII Guidelines.

In summary, the following National sites are considered receptors for the proposed road development:

- Moycullen Bogs NHA (Lough Inch/Na Foraí Maola Thair, Tonabrocky and Letteragh)
- Galway Bay Complex pNHA
- Lough Corrib pNHA

A breakdown of the groundwater bodies that contribute to those NHA identified above to be included in the evaluation of impacts are summarised below in **Table 10.14**.

Table 10.14: Summary of groundwater bodies traversed by the proposed road development that contribute to National Heritage Areas (NHA) and proposed National Heritage Areas (pNHA)

Groundwater Body	Lough Corrib pNHA	Galway Bay Complex pNHA	Moycullen Bogs NHA	Moycullen Bogs at Tonabrocky NHA	Moycullen Bogs at Letteragh NHA
Spiddal GWB	-	Contributes	Contributes	Contributes	Contributes
Maam Clonbur GWB	Contributes	Contributes			Contributes
Ross Lake GWB	Contributes	Contributes	-	-	-
Lough Corrib Fen 1 (Menlough) GWB and Lough Corrib Fen 1 (Lackagh) GWB	Contributes	Contributes	-	-	-
GWDTE Lough Corrib Fen 2 GWB	Contributes	Contributes	-	-	-
GWDTE Lough Corrib Fen 3 & 4 GWB	Contributes	Contributes			
Clare-Corrib GWB	Contributes	Contributes	-	-	-
Clarinbridge GWB	-	Contributes	-	-	-

Annex I habitats

In addition to the European sites, **Chapter 8, Biodiversity** details Annex I water dependant habitat that are outside of the European site boundaries. These habitat names are listed in **Table 10.15** below (refer to **Chapter 8, Biodiversity** for further details on the habitat). The locations of Annex I habitat are presented on **Figure 10.5.002**.

Table 10.15: Annex I water dependant habitat

Annex I habitat code	Habitat name
4010	Wet heath
6410	Molinia meadows
6430	Hydrophilous tall herb
*7130/7130	Blanket bog (active*)
7140	Transition mires
7150	Rhynchosporion depressions
*7210	Cladium fen*
*7220	Petrifying Springs*
7230	Alkaline fens
*8240	Limestone pavement*
*91E0	Residual alluvial forests*
*3180	Turloughs*

Notes: Denotes a priority habitat*

On the Galway Granite Batholith, the Annex I habitats outside of European and National sites include wet heath, blanket bog and Molinia Meadows. On the Visean Undifferentiated Limestone the Annex I habitats outside of European and National sites include Turloughs, Limestone pavement, Petrifying springs. Annex I habitats are ranked as having a 'Very High' importance, and unless shown to be beyond the potential zone of contribution, are considered in the evaluation of impacts assessment.

Like the Moycullen Bogs, as described in the section on NHA, the surface water ponding within wetland sites on the Galway Granite Batholith are not derived from groundwater, rather that they are caused by ponding above rock head where the rainfall and runoff is perched and trapped by basins in the bedrock topography. These include the following wetlands:

- Wetland habitats in townlands of Na Foraí Maola Thiar (Ch. 0+650 to Ch. 0+750), Na Foraí Maola Thoir (Ch. 1+250 to Ch. 1+500), Troscaigh Thiar (Ch. 1+850 to Ch. 2+400), Bearna (Ch. 2+600 to Ch. 3+100), Aille (Ch. 3+300 to Ch. 3+900) and Ballyburke (Ch. 4+800 to Ch. 5+900)
- Wetland habitats at National University Galway (Ch. 8+800 to Ch. 8+950 and Ch. 9+150 to Ch. 9+250)

Karst features are considered in this section of the assessment based on the water dependent ecology that they support. Three Turloughs (referenced as K20, K31 K72 in the karst database) were identified during the field surveys and their locations are presented in **Figure 10.5.002**. The Turloughs are all located in different groundwater bodies as follows:

- K31 is located in the Lough Corrib Fen 1 (Menlough) GWB

- K20 is located in the Lough Corrib Fen 2 GWB
- K72 is located in the Clare-Corrib GWB

Turlough K31 is crossed to the proposed road development and in this regard is included as a receptor in the evaluation of impacts.

Turlough K20 is located 425m north of the proposed road development in an adjacent GWB. Although in a separate GWB, the feature lies within 250m of the groundwater divide between Lough Corrib Fen 1 (Menlough) and Lough Corrib Fen 2, and as such is included as a receptor in the evaluation of impacts.

Turlough K72 is located in the same groundwater body as the proposed road development albeit 500m up-gradient of it. Turlough K72 is included as a receptor in the evaluation of impacts.

Limestone pavement is also considered in this section as it is present in the region between Lackagh Quarry and Menlough (**Chapter 8, Biodiversity**). Whilst Limestone pavement habitat is not dependent on groundwater it does require the development of a free draining upper zone in the limestone (referred to as epikarst) that rapidly drains rainfall into the aquifer so as not to cause ponding.

Limestone pavement is considered as a hydrogeological receptor as it is susceptible to groundwater level rise and could be impacted if groundwater were to flood the habitat. Limestone pavement is also described as a receptor in both **Chapter 8, Biodiversity** and **Chapter 9, Soils and Geology**. Limestone pavement ecosystems are included as potential hydrogeological receptors.

Lackagh Quarry includes 27 (No.) seepages points, which are mainly located on the northern quarry faces. **Chapter 8, Biodiversity**, classifies six of these seepages as petrifying springs, which have tufa (calcium carbonate) deposition. Hydrogeological observation of all the seepages concludes that all are seasonal and are generally only active between September and May, but they can also activate following prolonged or heavy summer rainfall. All the seepages including the six identified as petrifying springs occur higher than the regional water table. All the seepages occur where karst flow paths through the unsaturated limestone bedrock have been intercepted by the quarry void.

As the petrifying springs are Annex 1 habitats dependant on recharge along karst pathways they ranked as ‘Very High’ in terms hydrogeology.

Non Annex I habitat

A number of locally important ecological habitat, which are dependent on water or hydrogeological characteristics, have been identified and these are included in the **Chapter 8, Biodiversity**. These include a wetland site on the Galway Granite Batholith and calcareous springs in Lackagh Quarry. These features are described in **Chapter 8, Biodiversity**.

The wetland site at Ch. 7+850 is similar in hydrogeological character to the Moycullen Bogs discussed earlier in this section on NHA. The site is located in a topographic hollow in the Galway Granite Batholith where surface water ponds. Often the Galway Granite Batholith forms basins in the rock topography and surface water ponds in these hollows and is slow to drain away. The wetland at Ch.

7+850 is where a fen is located in a hollow on the highest point in the granite topography.

Of the 27 (No.) seepages identifies in Lackagh Quarry a total of 21 (No.) are classified in **Chapter 8, Biodiversity** as being calcareous springs, which is a non-annex 1 habitat. These seepages are seasonal and typically flow between September and may or following prolonged or heavy summer rainfall.

10.3.4.4 Groundwater Dependent Surface Water Features

As presented in the conceptual site model, the study area includes surface water features that are dependent on groundwater. These include the River Corrib, Ballindooley Lough, Coolagh Lakes, Turlough K20, Turlough K31, Turlough K72 and Terryland River. It is noted that whilst the Eastern Coolagh Spring has the potential for groundwater contribution, Coolagh Lakes is not dependent on this spring. Coolagh Lakes is however dependent on the Western Coolagh Spring.

Of these the River Corrib, Ballindooley Lough, Coolagh Lakes, Turlough K20, Turlough K31 and Turlough K72 are part of a European sites or Annex I habitat outside of European sites and have been described in previous sections.

Groundwater can contribute to the Terryland River and also the River Corrib via the Terryland River but only during times of a high water table. In this regard groundwater can provide a significant baseflow to the Terryland River but, unusually, only during winter. On the basis that groundwater contributes to the River Corrib which is part of the Lough Corrib cSAC is considered to have an ‘extremely high’ importance rating but only when flow in the Terryland River has reversed its normal flow.

10.3.4.5 Summary

This section has identified all hydrogeological receptors within the study area that have the potential of being impacted by the proposed road development. Hydrogeological receptors are divided in three sub categories, ecosystems, surface water and resources. Those sites and features from each of these three subcategories within the study area are summarised below in **Table 10.16**.

Table 10.16: Ranking of Importance of all hydrogeological features within the project study area

Feature	Location relative to proposed road development	Importance Ranking	Justification
Groundwater Resources			
Poor Bedrock Aquifer (Pl)	Section 1 of proposed road development	Low	Poor Bedrock Aquifer
Regionally Important Aquifer (Rkc)	Sections 2, 3 and 4 of the proposed road development	Very High	Regionally Important Aquifer (Rkc)
Groundwater supplies (Wells and springs)			

Feature	Location relative to proposed road development	Importance Ranking	Justification
Knocknacarra GWS (W50-01)	1km	Medium	Group water scheme supplying up to 50 houses
W50-02	2km	Low	Agricultural / Domestic supply
W50-03 04, 05, 06 and 07	2km	Low	Agricultural / Domestic supply
W50-08	1.4km	Low	Agricultural / Domestic supply
W50-09	0.5km	Low	Agricultural / Domestic supply
W50-10	0km	Low	Agricultural / Domestic supply
W50-11	0.5km	Low	Agricultural / Domestic supply
W50-12	0km	High	Commercial supply 250m^3/d
W50-13 and W50-14	0km	Very High	Commercial supply 2,000m^3/d
W50-15	0km	High	Commercial supply 380m^3/d
W100-01 & 02	0.6km	Low	Agricultural / Domestic supply
W100-03, 04, 05 and 06	0.3km	Low	Agricultural / Domestic supply
W500-01	0.8km	Low	Agricultural / Domestic supply
W1000-01	0.5km	Low	Agricultural / Domestic supply
W1000-02	0.2km	Low	Agricultural / Domestic supply
W1000-03	1.1km	Low	Agricultural / Domestic supply
W1000-04	0.5km	Low	Agricultural / Domestic supply
G50-01	0.1km	Low	Geothermal well
Surface Water Features			
Terryland River	0.6km	Extremely High	Contributes to River Corrib during peak groundwater levels
Ecosystems			
Galway Bay Complex cSAC	0.8km	Extremely High	European site

Feature	Location relative to proposed road development	Importance Ranking	Justification
Inner Galway Bay SPA	1km	Extremely High	European site
Lough Corrib SPA	0km	Extremely High	European site
Lough Corrib cSAC	0km	Extremely High	European site
Ballindooley Lough	0.1km	Extremely High	Supporting feature for Lough Corrib SPA
Moycullen Bogs	0.2km	Very High	National site
Moycullen Bogs (Tonabrocky)	0.3km	Very High	National site
Moycullen Bogs (Letteragh)	0km	Very High	National site
Lough Corrib NHA	0km	Very High	National site
Galway Bay NHA	0.2km	Very High	National site
Turlough K20	0.4km	Very High	Annex 1 habitat
Turlough K31	0km	Very High	Annex 1 habitat
Turlough K72	0.5km	Very High	Annex 1 habitat
Petrifying springs (Lackagh Quarry)	0km	Very High	Annex 1 habitat
Calcareous springs (Lackagh Quarry)	0km	Low	Locally important habitat
Fen Ch. 7+850	0km	Low	Locally important habitat

10.4 Characteristics of the Proposed Road Development

A detailed description of the proposed road development and construction work is provided in **Chapter 5, Description of Proposed Road Development** and **Chapter 7, Construction Activities**. This section outlines the characteristics and activities of the proposed road development which will interact with hydrogeology and hydrogeological receptors.

The elements of the proposed road development that will interact with the hydrogeological environment are those activities that have the capacity to change the groundwater regime in terms of recharge groundwater levels and water quality. These activities could be:

- **Construction:** dewatering of the bedrock aquifer for cuts or structures, accidental spillages of potentially polluting materials etc.
- **Operation:** discharge of road drainage; road cuts intercepting groundwater or structures (tunnels, sealed cuttings) acting as a barrier to flow

The profile of the proposed road development presented in **Figure 10.6.101** to **Figure 10.6.112** shows the locations where the proposed road development is in cutting, fill and at grade as well as showing the location of minimum and maximum groundwater levels for comparison.

Lowering of groundwater levels is referred to as water table ‘draw down’. **Table 10.17** summarises the excavations along each section of the proposed road development and identifies those sections of the proposed road development that will incur drawdown. Based on properties for the aquifers (**Table 10.10**) the maximum drawdown from the cutting is calculated, which is included in **Table 10.17** as a measurement from the footprint of the proposed road development.

With respect to the aquifer types discussed in **Section 10.3.3** the location and extent of excavations can be summarised as:

- Galway Granite Batholith: there are seven road cuttings (**Table 10.17**) namely, EW01, EW02 (three cuttings), EW04, EW07 and EW11. There are bridge structures at Troscaigh (S01/01), Aille (S03/01), Rahoon (S06/01), Letteragh (S07/01), N59 Link Road North and South (S07/02) and the N59 Moycullen Road (S08/02).
- Visean Undifferentiated Limestone: includes EW22, EW25, EW27, EW28 and EW34-35 (combined) (five cuttings) (**Table 10.17**). There are two tunnels, Lackagh Tunnel (S11/01) and Galway Racecourse Tunnel (S14/02) both of which have approaches. Bridge structures comprise of one crossing of the River Corrib (S08/04), one viaduct at Menlough (S10/01) to cross limestone pavement and road bridges for Menlo Castle Boithrin (S09/01), Coolagh Road (S10/02), the N84 Headford Road (S12/01), Wildlife Overpass Castlegar (S12/02), School Road (S13/01), N83 Tuam Road (S13/02), Park Road Link (S14/01), Monivea Road (S15/01) and Coolagh Junction (S16/01 and S16/02).

The maximum depth of the proposed finished road level below ground level for each cut section is presented in **Table 10.17**. The excavation depths for foundations and drainage have a maximum cut depth elevation of 3m below the finished road elevation, which is applied to the full length of the proposed road development. This is an over estimation on the maximum potential cut depth for drainage and foundations.

As outlined **Section 10.4**, the construction schedules for Lackagh Tunnel and the Menlough Viaduct shall accommodate the seasonal groundwater fluctuation so that construction works always occurs above the water table and dewatering in the bedrock aquifer is not required. For this reason, there will be no lowering in groundwater levels at these locations and accordingly the drawdown is represented as ‘0m’ in **Table 10.17**.

Table 10.17: Summary of earthwork (EW) locations for the proposed road development

Feature type	Earth works Ref no.	Approx. Chainage	Length (m)	Max depth of finished road level (m BGL)	Max depth of construction excavation (m BGL)	Depth to peak winter groundwater level (m BGL)	Max groundwater drawdown (m)	Max Zone of influence radius (m) from footprint of the proposed road development
Section 1 Galway Granite Batholith – R336 to N59 Moycullen Road								
Road Cutting	EW01	0+000 – 0+500	500	1.3	4.3	1.1	3	15
Road Cutting	EW02	1+150 – 1+350	200	0.9	3.9	1.9	2	9
Road Cutting	EW02	1+600 – 1+950	350	1.0	4.0	1.1	3	14
Road Cutting	EW02	2+230 – 2+640	410	3.1	6.1	3.6	2	12
Road Cutting	EW04	3+100 – 4+080	980	5.9	8.9	1.5	8	35
Road Cutting	EW07	5+250 – 5+580	330	5.3	8.3	3.4	5	23
Road Cutting Letteragh Junction	EW11	7+600 – 8+280	690	14.4	17.4	5.7	12	54
Section 2 & 3 Visean Limestone Undifferentiated - River Corrib to N83 Tuam Road								
River Corrib Structure (S06/04)	EW15	9+300 – 9+500	200	(Above ground)	(Above ground)	(Above ground)	0	0
Menlough Viaduct (S10/01)	EW17	9+500 – 10+100	600	(Above ground)	(Above ground)	(Above ground)	0	0

Feature type	Earth works Ref no.	Approx. Chainage	Length (m)	Max depth of finished road level (m BGL)	Max depth of construction excavation (m BGL)	Depth to peak winter groundwater level (m BGL)	Max groundwater drawdown (m)	Max Zone of influence radius (m) from footprint of the proposed road development
Western Approach to Lackagh Tunnel	EW19	10+810 – 11+140	350	13.5	16.5	12.2	0	0
Lackagh Tunnel (S11/01)	EW20	11+140 – 11+420	270	Bored tunnel	Bored tunnel	Bored tunnel	0	0
Road Cutting	EW22	11+720 – 11+920	200	24.6	27.6	35.5	0	0
Road Cutting	EW25	12+500 – 12+920	370	7.6	10.6	15.6	0	0
Road Cutting	EW27	13+050 – 13+650	600	12.0	15.0	12.1	3	70
Section 4 N83 Visean Limestone Undifferentiated Tuam Road to existing N6								
Road Cutting	EW28	14+150 – 14+450	300	12.3	15.3	18.6	0	0
Western Approach to Galway Racecourse Tunnel	EW30	14+450 – 14+950	500	11.4	14.4	18.5[*5]	2	14
Galway Racecourse Tunnel (S14/02)	EW31	14+950 – 15+190	240	9.2	12.2	8.9	4	35
Eastern Approach to Galway Racecourse Tunnel	EW32	15+190 – 15+500	310	8.7	11.7	7.8	4	35

Feature type	Earth works Ref no.	Approx. Chainage	Length (m)	Max depth of finished road level (m BGL)	Max depth of construction excavation (m BGL)	Depth to peak winter groundwater level (m BGL)	Max groundwater drawdown (m)	Max Zone of influence radius (m) from footprint of the proposed road development
Road Cutting	EW34-35	16+200 – 17+500	740	6.8	9.8	11.9*6	2	12

Notes:

Structure depths are presented to 10cm. Predicted drawdown and radius are rounded up to nearest 1m.
The maximum depth of proposed road level refers to the finished road level.
Max drawdown depth = Max baseline groundwater level - (max finished road level - 3m over excavation for drains)
*Maximum groundwater level uses maximum groundwater levels measured during the project monitoring period 2015 - 2017 (**Section 10.3.2**) for the chainage with the maximum excavation depth*
Winter water table at eastern end of cutting (Ch. 14+950) has seasonal peak 1.6m higher than max excavation depth
Winter water table at western end of cutting (Ch. 16+200) has seasonal peak 1.3m higher than max excavation depth

The drainage design of the proposed road development is presented in **Chapter 5, Description of the Proposed Road Development**, and is summarised below for the four hydrogeological sections:

- Section 1 – R336 to N59 Moycullen Road: Ch. 0+000 to Ch. 8+850
  - Permeable drains where possible on mainline, side roads and service roads
  - Treated road runoff discharged to surface watercourse (refer to **Chapter 11, Hydrology**) or public sewers
  - Permeable sub-surface groundwater interception drains in road cuttings
- Section 2 - N59 Moycullen Road to River Corrib Ch. 8+850 to Ch. 9+400
  - Sealed drains on mainline, side roads and service roads
  - Discharge of road runoff to River Corrib (refer to **Chapter 11, Hydrology**)
- Section 3 - River Corrib to N83 Tuam Road Ch. 9+400 to Ch. 14+000
  - Sealed drains on mainline, side roads and service roads
  - Discharge of treated road runoff to ground via infiltration basins in the absence of surface water (refer to **Chapter 11, Hydrology**) or public sewers
  - Permeable sub-surface groundwater drains in all cuttings
- Section 4 – N83 Tuam Road to existing N6
  - Sealed drains on mainline, side roads and service roads
  - Discharge of treated road runoff to ground via infiltration basins in the absence of surface water features or public sewers
  - Permeable sub-surface drains in all cuttings

The assessment of the potential impacts that these design elements may have on the hydrogeological environment is presented in **Section 10.5**.

10.5 Evaluation of Impacts

10.5.1 Introduction

The potential impacts on hydrogeology receptors from the proposed road development are presented in this section. An assessment of potential impacts for the construction phase is presented in **Section 10.5.3** and during the operation phase in **Section 10.5.4**.

Hydrogeological receptors within the study area are listed and ranked for importance in **Section 10.3.3** for each of the four hydrogeological sections. A summary of these rankings is presented in **Table 10.16**.

This section ranks the Magnitude and Significance of any potential hydrogeological impacts in line with TII Guidelines. Where hydrogeological impacts are predicted then these are also assessed for interaction with other aspects of the environment, most notably Biodiversity, Soils and Geology, Hydrology and Material Assets.

10.5.2 Do-Nothing Scenario

In the absence of the proposed road development then the baseline hydrogeological environment will remain as presented in **Section 10.3**.

10.5.3 Construction Phase

Construction activities can interact with hydrogeological receptors by changing the groundwater regime that a receptor is dependent upon. The potential impacts outlined in this section are pre-mitigation. Mitigation measures are described in **Section 10.6** and residual impacts post mitigation are outlined in **Section 10.7**.

There are a number of ways the hydrogeological environment may potentially be impacted during the construction phase and these include:

- the removal of the aquifer during excavations
- changes in recharge characteristics
- changes in groundwater levels
- changes in water quality

These potential changes to the groundwater regime are considered here and the interaction of these changes on receptors are considered below for groundwater resources (**Section 10.5.1**), groundwater supplies (**Section 10.5.2**), groundwater dependant habitats (**Section 10.5.3**) and groundwater contributions to surface water (**Section 10.5.4**).

Removal of part of the aquifer occurs in cut sections where saturated rock is removed. Those cuttings that intercept groundwater will lead to a reduction in groundwater level, the aquifer saturated thickness and the aquifer unsaturated thickness for the cutting footprint. If groundwater is not intercepted, then there will only be a reduction in the unsaturated thickness.

The concept of recharge is explained in **Section 10.3**. During construction where vegetation is removed then there will be an increase in the quantity of effective rainfall available to recharge to ground or runoff as surface water. Where vegetation is removed then there typically is an increase in the quantity of runoff. Any potential impacts of this on the identified receptors are discussed further below where relevant.

Groundwater levels will be lowered by dewatering of the bedrock aquifer during the construction phase of the proposed development for those elements of the road being constructed below the water table. These include road cuttings and construction phase excavations for drainage (attenuation ponds, infiltration ponds, stream realignment) as well as excavations for structures including bridges, viaducts, tunnels and underpasses. This section of the report outlines how the groundwater levels will change during the construction phase. The potential impacts on specific receptors are discussed below, which also includes potential impact on groundwater levels from the interception of karst pathways during construction.

The drawdown extents are presented in **Figure 10.7.101** to **Figure 10.7.114** for the construction phase for the full dataset (road cuttings and drainage excavations combined). A summary extract of the drawdown extents at individual road cuttings (road cuttings and drainage excavations combined) are presented below in **Table 10.17**. The Zone of Influence (ZoI) of the cutting / dewatering location is the area within which groundwater levels are affected by dewatering of the bedrock aquifer – outside of this area groundwater levels will remain at their natural level. The ZoI is presented as a radius on either side of the proposed road development, which is calculated using the upper range of aquifer properties and the hydraulic gradient of the water table. The detailed calculations are presented in **Appendix A.10.6** and summarised in **Table 10.17**. The assessment of drawdown is conservative as it assumes that drainage excavation extends across the full width of the footprint of the proposed road development, when in reality the excavations only extend part of the way.

In summary, **Table 10.17** identifies that groundwater levels will be lowered during the construction phases at the following sections:

- Section 1 (Galway Granite Batholith): EW01, 02 (three cuttings), 04, 07 and 09. EW11 includes the N59 Link Road North and South
- Sections 2 - 4 (Visean Undifferentiated limestone): EW27 and Galway Racecourse Tunnel and its approaches. The dewatering of the bedrock aquifer in EW27 will only be required seasonally

The quality of groundwater is potentially at risk during construction and activities on site are managed in accordance with guidelines to ensure that this potential risk managed appropriately. Risk to groundwater quality derives from the following main sources:

- storm runoff, which can have high turbidity
- occurrence of karst, which can lead to point recharge input to the aquifer
- Accidental spillages of polluting materials on site
- Vandalism

The above risks are assessed for receptors in the below **Section 10.5.3.1** to **Section 10.5.3.4**. Management of the above risks are dealt with by mitigation measures, which are detailed in **Section 10.6**.

10.5.3.1 Potential Impact to Groundwater Resources

The potential impact assessment on the groundwater resources during the construction phase considers the impact that the changes in the groundwater regime and groundwater quality have on the characteristics of the two aquifers. The potential impacts on each of these aquifers is assessed below.

10.5.3.1.1 Galway Granite Batholith (Section 1)

In line with TII guidance, the magnitude of the impact on the aquifers within the study is based on the portion of the aquifer that will be removed. The Pl Galway

Granite Batholith is 2,378km^2 (2,378,000,000m^2) in size (GSI Groundwater data viewer) and 1,000m thick (Pracht, 2015), giving an aquifer volume of 2,824,800,000,000m^3.

As outlined in **Chapter 9, Soils and Geology**, 905,345m^3 of granite will be excavated for the construction of the proposed road development. This volume is a very small percentage of the aquifer volume and for this reason, in line with TII rating, the Magnitude of the impact on the aquifer is Negligible and the Significance of the impact is Imperceptible.

Section 10.5.3 highlights that changing the recharge characteristics has the potential to impact the aquifer. GSI data indicates that the recharge rate to the Galway Granite Batholith is 100mm/yr (**Table 10.5**) and this will not change during construction. In line with TII rating, the Magnitude of the impact on the aquifer from changing recharge is Negligible and the Significance of the impact is Imperceptible.

Changing groundwater levels during construction activities may affect the aquifer characteristics. Eight locations have been highlighted in **Section 10.5.3** where groundwater levels will be lowered locally during construction.

Table 10.17 presents the Zone of Influence (ZoI) for each of these, which is the area away from the proposed road development within with groundwater levels will be lowered during construction. The largest drawdown ZoI occurs at the N59 Letteragh Junction (EW11). Based upon the assessment undertaken (**Appendix A.10.6**) the drawdown at this junction will extend for up to 54m from the edge of the footprint of the proposed road development.

Owing to the low aquifer properties of the Galway Granite Batholith the expected inflows from the construction are expected to be low. During construction the quantities of water intersected will initially be higher as the groundwater storage in the bedrock is tapped into, when the storage has been drained then the quantities that are intercepted will relate to recharge within the ZoI. Groundwater intercepted during construction will remain within the surface water catchment that they would naturally have been received by.

This, along with the minimal influence of the construction activities on the proposed road level indicates that, in line with TII rating, the Magnitude of the impact on the aquifer from changing groundwater levels is Negligible and the Significance of the impact is Imperceptible.

As outlined in **Section 10.5.3** suspended solids in site runoff is the prime concern with pollution from accidental spillages or vandalism also being a risk. Based on the recharge cap of 100mm more than 90% of the effective rainfall during construction will remain overland flow and will not recharge to ground. Spillages, accidental or by vandalism, the low infiltration rate will promote runoff rather than infiltration.

Pollutants that do infiltrate to ground will have limited mobility and will be limited to the construction footprint. On this basis the risk to the groundwater in the Galway Granite Batholith is limited to the construction footprint and not beyond it. In the unlikely event of significant flow paths (fault or fracture zones) being encountered during construction, then these shall be mitigated against using the same methodology as the Karst Protocol (refer to **Section 10.6**). The ZoI for construction phase pollution risk is presented for the Galway Granite Batholith in **Figure 10.7.101** to **Figure 10.7.105**.

The balance of rock excavated in cuttings and used for embankments and fill calculates a surplus of granite but a deficit of limestone. Due to the chemically inert nature of granite, if it is transported and used on embankments in limestone areas then there is no water quality concerns in terms of hydrogeology.

If any of these unplanned activities which have the potential to impact water quality occur, these have the potential to contaminate groundwater. In line with TII guidance, the magnitude of this potential impact on the aquifer is Moderate Adverse and the significance Significant / Moderate.

10.5.3.1.2 Visean Undifferentiated Limestone (Sections 2, 3 & 4)

In line with TII guidance, the magnitude of the impact on the aquifers within the study is based on the portion of the aquifer that will be removed. The Rkc Visean Undifferentiated Limestone aquifer is 7,062km^2 (7,062,000,000m^2) in size (GSI Groundwater data viewer) and 400m thick (Pracht, 2015), giving an aquifer volume of 2,824,800,000,000m^3.

As outlined in **Chapter 9, Soils and Geology**, 2,096,175m^3 of limestone will be excavated for the construction of the proposed road development. This volume is a very small percentage of the aquifer volume and for this reason, in line with TII rating, the Magnitude of the impact on the aquifer is Negligible and the Significance of the impact is Imperceptible.

Section 10.5.3 highlights that changing the recharge characteristics has the potential to impact the aquifer. The effect of an increased recharge in areas where vegetation has been removed may cause a groundwater rise below the footprint of the proposed road development due to an increase in recharge. Based on the baseline recharge quantities listed in **Table 10.5**, and the increase in recharge/runoff being equal then recharge is estimated to rise to 705- 803mm/yr and runoff to 447-545 mm/yr. Using these estimations there will be a temporary increase in winter groundwater levels of up to 0.1m during the construction period (**Appendix A.10.6**).

Where infiltration basins are used to discharge runoff during the construction period then there will be modest temporary rises in groundwater level at these locations, of up to approximately 0.4m. Calculations for the estimated groundwater level rise are presented in **Appendix A.10.6**).

In conclusion, the removal of vegetation will increase effective rainfall and lead to increases in recharge and runoff in the Visean Undifferentiated Limestone. It is estimated that there will be a temporary rise of up to 0.1m in peak groundwater levels below the construction site.

If karst is intercepted in any of these earthworks or infiltration basin excavations, then there is a risk of point recharge from construction site runoff directly to the aquifer. If karst is encountered during construction then the Karst Protocol will be implemented, which is a project specific procedure that is detailed in the Construction Environmental Management Plan (CEMP) (refer to **Appendix A.7.5**) and also presented in **Section 10.6 Mitigation Measures**.

For those sections of the aquifer which will not be subject to the influence of dewatering, in line with TII rating, the Magnitude of the impact on the aquifer from changing recharge rates is Negligible and the Significance of the impact is Imperceptible as the increases will not lead to groundwater flooding.

Changing groundwater levels during construction activities may affect the aquifer characteristics. Three locations have been highlighted in **Section 10.5.3** where groundwater levels will be lowered locally during construction.

Table 10.17 presents the ZoI for each of these, and this is the area away from the proposed road development within with groundwater levels will be lowered during construction. However, it should be noted that due to the design of the proposed road development, where dewatering of the bedrock aquifer will not be undertaken in the most sensitive areas, the drawdown and zones of influence associated with the construction impacts are relatively small.

For example, the largest ZoI in the Visean Undifferentiated Limestone will be observed in EW27 which lies west of the N83 Tuam Road. The groundwater levels recorded in this part of the Clare-Corrib GWB show a seasonal variation of 9m (ref BH3/34) and based on the design elevations for the cutting (refer to **Figure 10.6.108**) then groundwater has the potential to enter the cutting only during peak winter water levels. The impact from the dewatering of the bedrock aquifer is localised around the cutting and calculated to have a maximum lateral extent of 70m (**Table 10.17**), which is calculated using the upper range of permeabilities measured from testing. In line with TII rating, the Magnitude of the impact on the aquifer from changing groundwater levels is Negligible and the Significance of the impact is Imperceptible.

For a number of the structure excavations concrete is required as part of the foundation construction, which may need to be poured into excavations. There is a risk that poured concrete may enter the aquifer if karst is present in the foundation excavations. If karst is present then the concrete could migrate into the aquifer and potentially block pathways, modifying flow paths to receptors. Of the GWB with karst there are three structures that have a risk to groundwater quality, namely the Corrib Bridge, Menlough Viaduct and Lackagh Tunnel. This risk requires mitigation which is presented in **Section 10.6**. In line with TII rating, the Magnitude of the impact on the aquifer from blocking conduits is High and the Significance of the impact is moderate adverse.

The overburden across the study area consists of glacial till derived from the underlying bedrock. The bedrock changes in Section 2 at the N59 Moycullen Road, from a granite to a limestone bedrock which have different chemical compositions.

If limestone derived material is placed over granite bedrock, surface water run-off or groundwater movements through the material have the potential to impact local areas of peatland habitats by changing the pH of the local groundwater. In line with TII rating, the Magnitude of the impact on the aquifer from placing non-native rock is small and the impact imperceptible. Due to the chemically inert nature of granite, if it is transported and used on embankments on limestone then there are no water quality concerns in terms of hydrogeology.

As outlined in **Section 10.5.3** unplanned discharges such as site runoff with a high proportion of fines / sediment or accidental spillages of fuel, lubricants have the potential to cause groundwater quality to deteriorate.

Unlike the low aquifer properties encountered in the granite, the limestone has a wide range of aquifer properties with zones where conduit flow can occur. Similarly, the Visean Undifferentiated Limestone has a high recharge coefficient when karst is present and in these areas runoff generally recharges to ground rather than becoming overland flow.

These features mean that if potential pollutants enter karst pathways then they can travel significant distances relatively quickly. The groundwater bodies (GWB) that have karst are Ross Lake GWB, Lough Corrib Fen 1 (Menlough) GWB, Lough Corrib Fen 1 (Lackagh) GWB, Lough Corrib Fen 2 GWB and Clare-Corrib GWB.

In the Clarinbridge GWB there are no recorded significant karst features and surface water ponding as well as overland flow occurs during storm events, which is due to the lower recharge rates that are present in this area. Infiltration to ground will diffuse and provide slow pathways to the groundwater table that will naturally promote settlement of fines. In the groundwater there will be significant dilution and some attenuation of any fines.

Earthworks along the proposed road development include areas where the subsoil is removed leaving a reduced thickness of subsoil or exposing the underlying limestone. The removal of subsoil will reduce the natural protection for groundwater and increases the groundwater vulnerability (**Table 10.4**). During construction the excavation of subsoil will increase the risk to groundwater from accidental pollution. The area’s most susceptible to pollution are those where the subsoil is already thin, which are the high and extreme areas presented in **Figure 10.7.106** to **Figure 10.7.114**.

Conversely, in the natural environment, recharge to limestone where there is no karst relies in part on storage in the overlying subsoil which provides superficial storage to the fracture flow network in the underlying limestone. In the situation where the subsoil is removed there is an increase in overland flow with recharge significantly reduced. As such, where the limestone bedrock is exposed there will be an increase in runoff except for in zones of weathered limestone or karst (in those GWB with karst). The potential impacts associated with this are discussed in **Chapter 11, Hydrology**.

For the Ross Lake GWB, Lough Corrib Fen 1 (Menlough) GWB, Lough Corrib Fen 1 (Lackagh) GWB, Lough Corrib Fen 2 GWB and the Clare-Corrib GWB where there is a potential for karst and point input of runoff the areas at higher risk of pollution is extended over the full extent downstream of the proposed road development. For the Clarinbridge GWB where aquifer properties are relatively low, this area encompass the full extent of the construction footprint.

Infiltration from construction runoff on the Visean Undifferentiated Limestone will occur both on the construction footprint and from infiltration basins. The infiltration basins will be excavated at the construction stage to allow their use during construction. These may act as a source of point contamination to the karst. In line with TII rating, the Magnitude of the potential impact on the water quality of the aquifer is high and the Significance of the impact is moderate adverse.

Hydrogeological mitigation measures are required to control runoff to limit the potential impacts of accidental discharges to groundwater quality during construction. These are outlined in **Section 10.6**.

10.5.3.2 Potential Impacts to Groundwater supplies

A number of groundwater abstractions which may be impacted by the proposed road development were identified in **Section 10.3.4.3**. If groundwater levels at supply wells were lowered due to construction dewatering of the bedrock aquifer, or the groundwater quality at these wells was impacted, it could render the wells unusable. For the case of geothermal wells, a reduction in groundwater level can reduce the heat supply if the well relies on groundwater for thermal conductance.

The potential impact of construction dewatering of the bedrock aquifer on the wells can be assessed by comparing the well locations to the drawdown zone of influence. If the wells are located within the zone of influence, then by the precautionary principle it is assumed that they will be impacted by dewatering of the bedrock aquifer.

The first consideration for water supply wells is to assess whether the water quality at a well will be impacted by construction activities, which depends on whether a well is up- or down-gradient of the proposed road development. If a well is up-gradient of the proposed road development, it cannot be impacted by any potentially polluting materials at the proposed road development.

If a well is down-gradient, then the travel time of any contamination to that well should be considered. The GSI determine the inner Source Protection Area as the area within which human activities may have an immediate effect on the source and it is defined by the 100-day time of travel (TOT) from any point below the water table to the source.

The 100-day TOT has been calculated for each well down-gradient of the proposed road development to determine if it may potentially be impacted.

There is one well in the granite down-gradient of the proposed road development. Based on maximum locally measured permeability of $4.6x10^{-7}$m/s [4], the distance which defines the 100-day TOT for this well is 80m.

There are 10wells in the limestone down-gradient of the proposed road development. Based on maximum locally measured permeability of $3.1x10^{-5}$m/s[4] for the Menlough and Ballindooley area and maximum locally measured permeability of $1.7x10^{-6}$m/s[4] for the Ballybrit to Briarhill area, then the distance

[4] This has been calculated based on the hydraulic conductivity rather than the average linear velocity. Using hydraulic conductivity to determine 100-TOT is considered to be more conservative.

which defines the 100-day TOT for these is 1,500m and 500m respectively (rounded up).

It should be noted that this is a highly conservative assessment as the 100-day TOT was derived based on the likelihood of microbial contamination. These contaminants are more mobile than those associated with road runoff, however, the resultant distance indicates the maximum travel distance in 100 days and allows an informed decision on whether there is any potential for the well to be impacted.

The assessment of the potential impacts on each individual well has been summarised in **Table 10.18**.

Table 10.18: Impact assessment of wells within the study area (pre-mitigation)

Feature	Location relative to radius of influence	Position relative to proposed road development	Within 100-day TOT of the well?	Potential impact	Magnitude of impact	Significance of impact
Knocknacarra GWS (W50-01)	Outside the zone of influence	Down-gradient	No	None	No Impact	N/A
W50-02	Outside the zone of influence	Down gradient	No	None	No Impact	N/A
W50-03 04, 05, 06 and 07	Outside the zone of influence	Down gradient	No	None	No Impact	N/A
W50-08	Outside the zone of influence	Down gradient	No	None	No Impact	N/A
W50-09	Outside the zone of influence	Up gradient	N/A	None	No Impact	N/A
W50-10	Inside the zone of influence	Below footprint of proposed road development	Yes	Well will be lost	Large adverse	Slight / moderate
W50-11	Outside the zone of influence	Down gradient	No	None	No Impact	N/A
W50-12	Inside the zone of influence	Below footprint of proposed road development	Yes	Well will be lost	Large adverse	Profound / Significant

Feature	Location relative to radius of influence	Position relative to proposed road development	Within 100-day TOT of the well?	Potential impact	Magnitude of impact	Significance of impact
W50-13 & W50-14	Inside the zone of influence	Below footprint of proposed road development	Yes	Both wells will be lost	Large adverse	Profound
W50-15	Inside the zone of influence	Below footprint of proposed road development	Yes	Well will be lost	Large adverse	Profound / Significant
W100-01 & 02	Outside the zone of influence	Down gradient	No	None	No Impact	N/A
W100-03, 04, 05 and 06	Outside the zone of influence	Up gradient	N/A	None	No Impact	N/A
W500-01	Outside the zone of influence	Down gradient	No	None	No Impact	N/A
W1000-01	Outside the zone of influence	Up gradient	N/A	None	No Impact	N/A
W1000-02	Outside the zone of influence	Down gradient	Yes	Potential water quality deteriorati on	Moderate adverse	Slight
W1000-03	Outside the radius of influence	Down gradient	No	None	No Impact	N/A
W1000-04	Outside the radius of influence	Down gradient	No	None	No Impact	N/A
G50-01 (Geothermal well)	Outside the radius of influence	Up gradient	N/A	None	No impact	N/A

This assessment highlights that five wells (W50-10, W50-12, W50-13, W50-14 and W50-15) will be permanently impacted. Accordingly, these will be removed as part of the proposed road development and decommissioned based on IGI (2007) and EPA (2013) guidelines.

One well (W1000-02) has a potential risk for water quality deterioration as it lies down gradient and within the 100-day TOT from the proposed road development.

10.5.3.3 Potential Impacts to Groundwater Dependent Terrestrial Ecosystems (GWDTE)

This section assesses potential impact to groundwater dependent habitats and limestone pavement habitat from the construction phase of the proposed road development. Ecosystems may be potentially impacted through accidental contamination of the groundwater which supports them, the alteration of groundwater levels and/or the reduction in the groundwater contribution to the ecosystem. The characteristics which determine the potential impact are:

- The proximity to the feature
- The level of hydraulic connection between the feature and the section of aquifer at the proposed road development i.e. is the feature in the same aquifer unit as the proposed road development, or is there a hydraulic divide between the feature and the proposed road development
- The groundwater flow direction in the vicinity
- The level of cut of the proposed road development, which may determine the degree of variation in the groundwater level and also the extent of dewatering which may occur
- The water quality of the feature and the groundwater from which it receives its baseflow

Those receptors which need an impact assessment have been identified in **Section 10.3.4.2**. Ecosystem receptors comprise of European sites (cSAC and SPA), National sites (NHAs and pNHAs) and Annex I habitats.

It should be noted that this chapter identifies the potential impacts to the hydrogeology that supports these ecological features and does not assess the Magnitude and Impact Significance of the habitats themselves, which is presented in **Chapter 8, Biodiversity** based on the information provided here.

European Sites

Four European sites have been identified as receiving groundwater from groundwater bodies that are traversed by the proposed road development. These include:

- Lough Corrib cSAC
- Lough Corrib SPA
- Galway Bay Complex cSAC
- Inner Galway Bay SPA

Ballindooley Lough is also included in this assessment as it supports the wintering birds of the Lough Corrib SPA and Galway Bay SPA but also includes Annex 1 habitat on the fringe of the lough. The receiving environment of Ballindooley Lough has been discussed in detail in **Section 10.3.3.2**.

The discussion of the characteristics of the Galway Granite Batholith in **Section 10.5.3.1.1** outlines the zones of influence for dewatering of the bedrock aquifer and the areas vulnerable to contamination. Based on these there will be no impact either from drawdown or water quality impacts from the proposed road development to European sites.

The discussion of the characteristics of the Visean Undifferentiated Limestone in **Section 10.5.3.1.2** outlines the zones of influence for dewatering of the bedrock aquifer and interception of karst pathways as well as the areas vulnerable to contamination.

For the Visean Undifferentiated Limestone, the drawdown zones of influence do not impact on any European sites or Ballindooley Lough. However, this section of the report provides additional detail on the construction in order to relate the conceptual model to any potential impacts that may arise during construction.

The Western Approach to Lackagh Tunnel (EW19) and Lackagh Tunnel (EW20) are discussed in the Lackagh Tunnel Appraisal Report, which is included in **Chapter 7, Construction Activities**. The hydrogeological setting of the Western Approach to Lackagh Tunnel (EW19) and Lackagh Tunnel (EW20) are located at the groundwater divide between Lough Corrib Fen 1 (Menlough) and Clare-Corrib GWBs.

Due to the dependency of Coolagh Lake (part of the Lough Corrib cSAC) on Western Coolagh Spring the design excludes dewatering of the bedrock aquifer within this spring’s catchment. Based on the mapping of groundwater levels (refer to **Figure 10.6.008**) this catchment encompasses the area Ch. 9+700 and Ch. 11+500.

Dewatering of the bedrock aquifer will not be permitted during construction so there is no reduction in groundwater flow transmitted by these pathways through the aquifer to the Western Coolagh Spring. By not dewatering, the boundary between Clare-Corrib GWB and Lough Corrib Fen 1 (Menlough) will not be impacted. All construction works will remain above the groundwater table for the duration of the works to ensure the groundwater table is not intercepted and dewatering of the bedrock aquifer is not required.

On this basis there will be no drawdown in the Western Approach to Lackagh Tunnel (EW19) and Lackagh Tunnel (EW20) and therefore no impact to the groundwater divide between the Lough Corrib Fen 1 (Menlough) GWB and the Clare-Corrib GWB or to the Lough Corrib cSAC.

In addition, as detailed in the Karst Protocol (refer to CEMP **Appendix A.7.5**), if karst conduits are encountered during the excavation of structure foundations, concrete poured in these may block the conduits. This may affect the hydrogeological regime of the groundwater body feeding the ecological receptors. Mitigation measures for this are presented in **Section 10.6**.

The bridge over the River Corrib (EW15) requires excavations on the east and west shore to install piers. These excavations will extend below the groundwater table and will require dewatering to enable dry working conditions. As the eastern excavations occur on the margins of the Lough Corrib Fen 1 (Menlough) GWB with the River Corrib, there is no potential for impact to Western Coolagh Spring, which is up-gradient of the location.

There are European sites that receive groundwater from GWB with karst pathways that the proposed road development traverses. These GWB and the European sites they contribute to are listed below:

- Lough Corrib Fen 1 (Menlough) GWB, from groundwater flowing westwards to Western Coolagh Spring and the River Corrib (Lough Corrib cSAC). Water emergent from Western Coolagh Spring is the main contribution to Coolagh Lakes.
- Clare Corrib GWB, from groundwater flowing southwards to Galway Bay. This also includes emergent groundwater to the Terryland River during times of high groundwater levels, which flows to the River Corrib (Lough Corrib cSAC). Groundwater contribution from Clare-Corrib GWB provides a minor component of flow to Galway Bay or River Corrib.

The extent of the area where contamination may extend to is caused by the potential presence of karst which could allow pathways to carry pollutants from the construction site or infiltration basins to receptors. Mitigation has been developed to accommodate potential karst and these are detailed in **Section 10.6**.

Ballindooley Lough is up gradient of the proposed road development and as such not considered to be at risk from pollution.

National Heritage Areas

Three National Heritage Areas have been identified as receiving groundwater from groundwater bodies that are traversed by the proposed road development. These include:

- Moycullen Bogs NHA (including Tonabrocky and Letteragh)
- Galway Bay Complex pNHA
- Lough Corrib pNHA

The hydrogeological assessment undertaken in **Section 10.5.3** identified a zone of influence for drawdown and an area more prone to potential pollution.

Based on the zones of influence extent for the Galway Granite Batholith, there will be no impact either from drawdown or water quality impacts from the proposed road development to NHA receptors. The Moycullen Bog at Letteragh is close to the proposed road development however, the calculated drawdown does not extend as far as the habitat. Moycullen Bog at Letteragh lies upgradient of the proposed road development and as such there is no risk of pollution.

For the Visean Undifferentiated Limestone the drawdown zones of influence do not impact on any NHA receptors. The zone of influence for water quality at the Clarinbridge GWB shows no impact to NHA receptors. However, the areas which may be prone to potential pollution shows a potential groundwater impact for:

- Lough Corrib Fen 1 (Menlough) westwards to Western Coolagh Spring and the River Corrib (Lough Corrib NHA)
- Clare Corrib GWB southwards to Terryland River, which flows to the River Corrib (Lough Corrib NHA) during times of high groundwater levels

The extent of the area where contamination may extend to is caused by the potential presence of karst which could allow pathways to carry pollutants from the construction site to receptors. Mitigation has been developed to accommodate potential karst and these are detailed in **Section 10.6**.

Annex I habitats

A number of Annex I habitats have been identified as water dependant and are located on groundwater bodies that are traversed by the proposed road development and are listed below:

- Wetland habitats in townlands of Na Foraí Maola Thiar (Ch. 0+650 to Ch. 0+750), Na Foraí Maola Thoir (Ch. 1+250 to Ch. 1+500), Troscaigh Thiar (Ch. 1+850 to Ch. 2+400), Bearna (Ch. 2+600 to Ch. 3+100), Aille (Ch. 3+300 to Ch. 3+900) and Ballyburke (Ch. 4+800 to Ch. 5+900)
- Wetland habitats at National University Galway (Ch. 8+800 to Ch. 8+950 and Ch. 9+150 to Ch. 9+250)
- Turlough K31 is located in the Lough Corrib Fen 1 (Menlough) GWB
- Turlough K20 is located in the Lough Corrib Fen 2 GWB
- Turlough K72 is located in the Clare-Corrib GWB
- Petrifying springs, located on the northern face of Lackagh Quarry
- Wetland habitats at Terryland River

The zone of influence for drawdown shows that impacts from groundwater lowering will occur to the Annex I habitats within the townlands of Na Foraí Maola Thiar (Ch. 0+650 to Ch. 0+750), Na Foraí Maola Thoir (Ch. 1+250 to Ch. 1+500), Troscaigh Thiar (Ch. 1+850 to Ch. 2+400), Bearna (Ch. 2+600 to Ch. 3+100), Aille (Ch. 3+300 to Ch. 3+900) and Ballyburke (Ch. 4+800 to Ch. 5+900).

Wetland habitats at NUIG Sporting Campus lie downgradient and upgradient of the proposed road development. Neither habitat at NUIG Sporting Campus lies within the drawdown ZOI, however, the habitat to the south, which lies downgradient, has the potential to be impacted from pollution.

Turlough K31 also lies within the footprint of the proposed road development but as it is traversed as part of the Menlough Viaduct. As the viaduct can be constructed without dewatering of the bedrock aquifer there will be no impact from groundwater lowering at turlough K31.

The extent of the area identified as being prone to potential pollution shows that Turlough K31 lies within this area but that Turloughs K20 and K72 lie beyond it. The potential impacts to Turlough K31 derive from the potential of karst being encountered during construction and as such pollution from the site draining to ground, and the turlough.

Petrifying springs have been included in **Chapter 8, Biodiversity** as occurring on the western face of the inactive Lackagh Quarry. The Petrifying springs occur as seepages that are located above the regional groundwater table, which occur from small pathways in the limestone bedrock that are fed by recharge. The source area for the seepages is the limestone pavement immediately north and west of Lackagh Quarry. These seepages have developed from the excavation of the quarry. Rock bolting is proposed to stabilise the quarry face at the eastern portal of Lackagh Tunnel in Lackagh Quarry. Rock bolting will have an insignificant impact on recharge pathways through the unsaturated zone. Concreting will not be part of the face stabilisation works.

Wetland habitats associated with the Terryland River are located on thick low permeability subsoils. The water dependence of these habitats is derived from water ponding on the surface rather and are therefore not groundwater dependant.

Local Ecosystems

A number of local ecosystems are identified in the **Chapter 8, Biodiversity** that are water dependant and these include a wetland site on the Galway Granite Batholith at Ch. 8+850 and quarry wall seepages in the Visean Undifferentiated Limestone in Lackagh Quarry that have calcareous springs.

Based on the zone of influence for draw down, the wetland site at Ch. 8+850 will be impacted by the drawdown and its southern margin where the groundwater level will lower during construction.

The calcareous spring locations identified in Lackagh Quarry are all located above the groundwater table and mainly in the western quarry face. All seepages occur above the water table and occur from recharge within the unsaturated zone. The proposed road development will not impact on water quality.

Summary

The hydrogeology of ecological receptors with dependence on groundwater have been assessed (in the absence of mitigation measures) for the construction phase of the proposed road development. The assessment takes into account receptors within the study area for both the drawdown zone of influence and areas which are potentially vulnerable to pollution. **Table 10.19** below provides a summary of the ecological receptors and identifies those that lie within the drawdown zone of influence and those areas that lie down gradient of the proposed road development and are at risk from pollution.

The magnitude and significance of hydrogeological impacts refer to potential changes in groundwater quantity and/or quality at the European or National site or groundwater dependent Annex I habitat. The assessment in accordance with TII Guidelines. For assessment on ecological impacts as a consequence of these potential hydrogeological impacts, please refer to **Chapter 8, Biodiversity**.

Table 10.19: Summary of potential hydrogeological impacts at GWDTE during construction phase (pre-mitigation)

Feature	Potential Impact to Groundwater Level	Potential Impact to Groundwater Quality	Magnitude of Hydrogeology Impact	Significance of Hydrogeology Impact
European Union sites				
Galway Bay Complex cSAC	Potential temporary quantity deterioration of groundwater in karst pathways to Galway Bay. The groundwater contribution from GWB is of insufficient magnitude to affect integrity	Potential temporary quality deterioration of groundwater in karst pathways to Galway Bay. The groundwater contribution from GWB is of insufficient magnitude to affect integrity	Negligible	Insignificant
Inner Galway Bay SPA	Potential temporary quantity deterioration of groundwater in karst pathways to Galway Bay. The groundwater contribution from GWB is of insufficient magnitude to affect integrity	Potential temporary quality deterioration of groundwater in karst pathways to Galway Bay. The groundwater contribution from GWB is of insufficient magnitude to affect integrity	negligible	Insignificant
Lough Corrib cSAC	Potential temporary quantity deterioration of groundwater in karst pathways within contributing GWB would lead to impact at Western Coolagh Spring, which is the main water contribution for Coolagh Lakes	Potential temporary quality deterioration of groundwater in karst pathways within contributing GWB would lead to impact at Western Coolagh Spring, which is the main water contribution for Coolagh Lakes	Large Adverse	Profound
	The groundwater contribution from GWB to River Corrib is of insufficient magnitude to affect integrity	The groundwater contribution from GWB to River Corrib is of insufficient magnitude to affect integrity	Negligible	Insignificant

Feature	Potential Impact to Groundwater Level	Potential Impact to Groundwater Quality	Magnitude of Hydrogeology Impact	Significance of Hydrogeology Impact
Lough Corrib SPA	No (upgradient of the proposed road development)	No (upgradient of the proposed road development)	N/A	N/A
Ballindooley Lough	No (upgradient of the proposed road development)	No (upgradient of the proposed road development)	N/A	N/A
National Heritage Sites				
Moycullen Bogs (Lough Inch/Na Foraí Maola Thair)	No (upgradient of the proposed road development)	No (upgradient of the proposed road development)	N/A	N/A
Moycullen Bogs (Tonabrocky)	No (upgradient of the proposed road development)	No (upgradient of the proposed road development)	N/A	N/A
Moycullen Bogs (Letteragh)	No (upgradient of the proposed road development)	No (upgradient of the proposed road development)	N/A	N/A
Lough Corrib NHA	Potential temporary quantity deterioration of groundwater in karst pathways within contributing GWB would lead to impact at Western Coolagh Spring, which is the main water contribution for Coolagh Lakes	Potential temporary quality deterioration of groundwater in karst pathways within contributing GWB would lead to impact at Western Coolagh Spring, which is the main water contribution for Coolagh Lakes	Large Adverse	Significant
	The groundwater contribution from GWB to River Corrib is of insufficient magnitude to affect integrity	The groundwater contribution from GWB to River Corrib is of insufficient magnitude to affect integrity	Negligible	Insignificant
Galway Bay NHA	Potential temporary quantity deterioration of groundwater in karst pathways to Galway Bay. The	Potential temporary quality deterioration of groundwater in karst pathways to Galway Bay. The groundwater contribution from	Negligible	Insignificant

Feature	Potential Impact to Groundwater Level	Potential Impact to Groundwater Quality	Magnitude of Hydrogeology Impact	Significance of Hydrogeology Impact
	groundwater contribution from GWB is of insufficient magnitude to affect integrity	GWB is of insufficient magnitude to affect integrity		
Annex I habitats (outside of European sites)				
Na Foraí Maola Thiar Ch. 0+650 to Ch. 0+750	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound
Na Foraí Maola Thoir Ch. 1+250 to Ch. 1+500	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound
Troscaigh Thiar (Ch. 1+850 to Ch. 2+400)	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound
Bearna (Ch. 2+600 to Ch. 3+100)	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound
Aille (Ch. 3+300 to Ch. 3+900)	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound
Ballyburke (Ch. 4+800 to Ch. 5+900)	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound
NUI Galway (Ch. 8+800 to Ch. 8+950	No (upgradient of the proposed road development)	No (upgradient of the proposed road development)	N/A	N/A
NUI Galway (Ch. 9+150 to Ch. 9+250	No Outside of drawdown zone of influence	Within area liable to contamination	Moderate Adverse	Profound / Significant
Turlough K20 (Menlough North East)	No Outside of drawdown zone of influence	No (upgradient of proposed road)	N/A	N/A
Turlough K31 (Menlough East)	No Outside of drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound

Feature	Potential Impact to Groundwater Level	Potential Impact to Groundwater Quality	Magnitude of Hydrogeology Impact	Significance of Hydrogeology Impact
Turlough K72 (Coolagh North)	No Outside of drawdown zone of influence	No (upgradient of proposed road)	N/A	N/A
Petrifying Springs (Lackagh Quarry)	Rock bolts may intersect recharge pathways	No Located above the groundwater table	Negligible	Insignificant
Local habitats				
Fen Ch. 7+850	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Slight / Moderate
Calcareous springs (Lackagh Quarry)	Rock bolts may intersect recharge pathways	No Located above the groundwater table	Negligible	Insignificant

On the basis of the above assessment impacts to groundwater dependant habitat are assessed based on the importance of the hydrogeology attribute and the magnitude of impact. Those features that lie beyond the zone of influence to hydrogeological impacts and away from the area vulnerable to contamination are assessed to have no impact.

10.5.3.4 Hydrogeological Impacts to Groundwater Dependent Surface Water Features

Groundwater contributes to surface water in the study area. In the area of the Galway Granite Batholith, the groundwater contribution is minimal, as evidenced by low baseflow. However, groundwater provides more significant contribution to baseflow in the area of the Visean Undifferentiated Limestone (refer to **Chapter 11, Hydrology**). Whilst, the River Corrib receives most of its contribution from upstream of the study area, surface water features such as Ballindooley Lough, Coolagh Lakes, turlough K20, Turlough K31, Turlough K72 and the Terryland River (during high groundwater levels), are dependent on groundwater. It is noted that whilst the Eastern Coolagh Spring has the potential for groundwater contribution, Coolagh Lakes is not dependent on this spring. Coolagh Lakes is however dependent on the Western Coolagh Spring.

Based on the ZoI for drawdown there will be no reduction in groundwater flow from the Galway Granite Batholith or the Visean Undifferentiated Limestone. Furthermore, for the Galway Granite Batholith those areas highlighted as being vulnerable to potential pollution do not extend to surface water features.

For the Visean Undifferentiated Limestone the areas which have been described as having karst or being highlighted as potentially vulnerable to pollution include surface water features dependant on groundwater. Of these features listed above Ballindooley Lough, Turlough K20, Turlough K72 have been described in **Section**

10.5.3.3 (Potential Impacts to GWDTE). As such, only the Terryland River is described under the heading of hydrogeological impacts to surface water.

The hydrogeology of the Terryland River is described in **Section 10.3.3**, which explains the importance of two estavelles at the eastern end of the river. Although the Terryland River sinks at the estavelles for most of the year, these reverse during peak groundwater levels and become resurgences. On these occasions groundwater from the Clare-Corrib GWB contributes to the River Corrib and the Lough Corrib cSAC. On this basis the Clare-Corrib GWB contributes Galway Bay during normal conditions but Galway Bay and the River Corrib during high groundwater levels.

The potential impact magnitude to the Terryland River during high groundwater is quantified as ‘Small Adverse’. As during these times the Terryland River is entirely groundwater fed, then the rating significance is ‘Significant’. The hydrological impacts are described in **Chapter 11, Hydrology**.

The magnitude and significance of hydrogeological impacts refer to potential changes in groundwater quantity and/or quality at receiving surface water from the proposed road development. The assessment is made in accordance with TII Guidelines. For assessment on surface water impacts as a consequence of these potential hydrogeological impacts, please refer to **Chapter 11, Hydrology**.

10.5.3.5 Summary

This section has provided a detailed assessment of the potential impacts to receptors for the proposed road development prior to implementation of mitigation measures. Based on the conceptual site model (**Section 10.3.3**) a zone of impact has been delineated for groundwater level drawdown. Areas that lie downgradient of the proposed road development have also been identified as being at risk from pollution, with the extent downgradient being dependant on the aquifer properties.

The design of the proposed road development is cognisant of the hydrogeological existing environment and specifically groundwater receptors. Below is a summary of the design measures incorporated into the design of the proposed road development for the construction phase:

- The design of the construction minimises areas of land stripping so as to reduce the increase in runoff from where vegetation (and evapotranspiration) is removed
- In the area of the Galway Granite Batholith the aquifer properties are poor and recharge is very low. In these areas runoff is managed on site and discharged to surface water (refer to **Chapter 11, Hydrology**). There is no reliance on groundwater infiltration where the road traverses the Galway Granite Batholith
- Groundwater inflows will occur in road cuttings due to the high water table in the Galway Granite Batholith. Where groundwater inflows occur these are likely to be minimal owing to the low aquifer properties. In the case of local zones of higher inflow, for example at a fault zone, then mitigation measures will be employed to control the inflow and isolate the pathway from the construction site

- The assessment has identified a risk specific to the Visean Undifferentiated Limestone where karst is present within the groundwater bodies that the proposed road development traverses. Karst has been identified in Lough Corrib Fen 1 (Menlough) GWB and Lough Corrib Fen 1 (Lackagh) GWB, GWDTE Lough Corrib Fen 2 GWB and the Clare-Corrib GWB. If karst was encountered in these groundwater bodies then there is a risk that runoff and accidental spills could impact on groundwater quantity and quality. These potential impacts require mitigation using the karst protocol, which is detailed in **Section 10.6** mitigation measures
- During construction of the proposed tunnel at Lackagh Quarry there is a risk of groundwater impacts if dewatering of the bedrock aquifer occurs, which could have hydrogeological impacts at Western Coolagh Spring which in turn could impact Coolagh Lakes which are part of Lough Corrib cSAC. Detail of the assessment of Lackagh Tunnel and its approaches are presented in **Appendix A.7.3**. For the tunnel section the eastern section of the western portal and approach the construction works will be restricted to above the groundwater table at all times
- At the eastern approach to Lackagh Tunnel support system of rock bolts will be used to stabilise the quarry face rather than concrete. Rock bolts will prevent impact to the petrifying springs and calcareous identified in the faces of Lackagh Quarry
- To facilitate groundwater flow around the completed tunnel the construction design includes a drainage blanket up to the winter groundwater level (+16.7mOD). It is envisaged that this will take the form of a drainage layer, drainage pipes or similar placed outside the permanent cast in-situ reinforced concrete tunnel lining and waterproof membrane
- The proposed finished level of the proposed road development at Lackagh Quarry will lie above the groundwater table, however, the embankment starter layer at the eastern approach would, in part, be submerged during peak winter groundwater high. In this regard the starter layer will be constructed so as not to dam groundwater in parts of the quarry floor. Similarly, the drainage network will not be installed during the seasonal groundwater high so as to avoid the need for dewatering of the bedrock aquifer and groundwater lowering
- A watertight seal will be installed on the road base of Lackagh Tunnel and its western approach and the cutting sides to protect against groundwater inflow. This area will be sealed during construction (and permanently) to +17.7mOD; which is derived from the groundwater high (+15.7mOD) plus 2m free board. Slope or retaining structures will be utilised from +17.7mOD to existing ground level where required

Based on the design measures above each of the receptors have been assessed. **Table 10.20** below provides a summary of impact magnitude and impact significance for those hydrogeological receptors considered at risk during the construction phase. The assessment of ecological and surface water receptors refers only to the hydrogeology of each location (refer to **Chapter 8, Biodiversity** and **Chapter 11, Hydrology**).

Table 10.20: Summary of impact magnitude and significance for hydrogeological aspects of receptors at risk during the construction phase of the proposed road development

Feature	Importance of Hydrogeology Attribute	Hydrogeology Impact Summary	Hydrogeology Impact Magnitude	Hydrogeology Impact Significance
Groundwater Resources				
Galway Granite Batholith (Pl)	Low	Permanent groundwater quality and quantity impacts	Negligible	Imperceptible
Visean Undifferentiated Limestone (Rkc)	Very High	Permanent groundwater quality and quantity impacts	Negligible	Imperceptible
Groundwater Supplies				
W50-10	Low	Well will be lost	Large adverse	Slight / moderate
W50-12	High	Well will be lost	Large adverse	Profound / significant
W50-13 & W50-14	Very High	Well will be lost	Large adverse	Profound
W50-15	High	Well will be lost	Large adverse	Profound / significant
W1000-02	Low	Potential risk to water quality	Moderate adverse	Slight
Ecological Receptors				
Lough Corrib cSAC	Extremely High	Potential temporary quantity and quality deterioration of groundwater in karst pathways within contributing GWB would lead to impacts at Western Coolagh Spring, which is the main water contribution for Coolagh Lakes	Large Adverse	Profound
		The groundwater contribution from GWB to River Corrib is of insufficient	Negligible	Insignificant

Feature	Importance of Hydrogeology Attribute	Hydrogeology Impact Summary	Hydrogeology Impact Magnitude	Hydrogeology Impact Significance
		magnitude to affect integrity		
Galway Bay Complex cSAC	Extremely High	Potential temporary quantity and quality deterioration of groundwater in karst pathways to Galway Bay. The groundwater contribution from GWB is of insufficient magnitude to affect integrity	Negligible	Insignificant
Inner Galway Bay SPA	Extremely High	Potential temporary quantity and quality deterioration of groundwater in karst pathways to Galway Bay. The groundwater contribution from GWB is of insufficient magnitude to affect integrity	Negligible	Insignificant
Lough Corrib pNHA	Very High	Potential temporary quantity and quality deterioration of groundwater in karst pathways within contributing GWB would lead to impacts at Western Coolagh Spring, which is the main water contribution for Coolagh Lakes	Large Adverse	Profound
		The groundwater contribution from GWB to	Negligible	Insignificant

Feature	Importance of Hydrogeology Attribute	Hydrogeology Impact Summary	Hydrogeology Impact Magnitude	Hydrogeology Impact Significance
		River Corrib is of insufficient magnitude to affect integrity		
Na Foraí Maola Thiar (Annex I) Ch. 0+650 to Ch. 0:750	Very High	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater levels below the habitat	Large Adverse	Profound
Na Foraí Maola Thoir (Annex I) Ch. 1+250 to Ch. 1+500	Very High	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater levels below the habitat	Large Adverse	Profound
Troscaigh Thiar (Annex I) (Ch. 1+850 to Ch. 2+400)	Very High	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater levels below the habitat	Large Adverse	Profound
Aille (Annex I) (Ch. 3+300 to Ch. 3+900)	Very High	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater levels below the habitat	Large Adverse	Profound
Ballyburke (Annex I) (Ch. 4+800 to Ch. 5+900)	Very High	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater	Large Adverse	Profound

Feature	Importance of Hydrogeology Attribute	Hydrogeology Impact Summary	Hydrogeology Impact Magnitude	Hydrogeology Impact Significance
		levels below the habitat		
NUI Galway (Annex I) (Ch. 9+150 to Ch. 9+250)	Very High	Potential contamination impact	Moderate Adverse	Profound
Turlough K31 (Annex I) Menlough East	Very High	Proposed road development traverses the habitat Potential temporary groundwater contamination impact	Large Adverse	Profound
Petrifying springs	Very High	Rock bolting to stabilise eastern portal of Lackagh Tunnel	Negligible	Insignificant
Unnamed Fen (Locally important) Ch. 7+850	Low	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater levels below the habitat	Large Adverse	Slight / moderate
Calcareous springs	Low	Rock bolting to stabilise eastern portal of Lackagh Tunnel	Negligible	Insignificant
Surface water				
Terryland River	Extremely High	Potential temporary water quantity and quality impact to Terryland estavelles (K87 & K96) during high groundwater levels when these outflows contribute to the River Corrib	Small Adverse	Significant

10.5.4 Operational Phase Impacts

There are a number of operation phase activities or features of the proposed road development that have the potential to cause hydrogeological impacts. The potential impacts of these on the hydrogeological receptors identified in **Section 10.3.4** are discussed in this section of the chapter. The potential impact outlined in this section are pre-mitigation. Residual impacts are outlined in **Section 10.7**.

As with construction activities, the main impacts to groundwater from operation arises from the potential to impact on groundwater level and groundwater quality. Operation can alter the groundwater regime by:

- Lowering of groundwater level from operational dewatering
- Raising groundwater levels by impeding or impounding groundwater
- Discharge of road runoff to ground

The quantification of these potential operational impacts are presented in this section of the chapter, while the impacts on receptors identified in **Section 10.3.4** are presented in **Section 10.5.4.4**. Many of these impacts are similar to the impacts quantified in the construction phase of this assessment e.g. the operation of road cuttings in the Galway Granite Batholith, and should be cross referenced to **Section 10.5.3** where necessary.

There will be no active dewatering of the bedrock aquifer required during the operation phase but passive dewatering will occur at a number of cutting locations and the drainage associated with the proposed road development will cause the groundwater levels to adjust locally.

The drawdown and ZoI for road cuttings was presented in **Table 10.17** of the construction impacts and should also be referred to when considering the impacts from the operation phase. It should be noted that all tunnels and associated approaches will be sealed as part of their construction where below the winter water table and so, for example, the Galway Racecourse Tunnel and approaches will require dewatering of the bedrock aquifer during construction but they will not require dewatering during operation. Dewatering of the bedrock aquifer either during construction or operation at Lackagh tunnel and its approaches is not permitted.

The potential impacts from interception of karst conduits was highlighted during the construction phase as having a potential impact on the hydrogeological regime by either modifying pathways (reactivating sediment filled karst or blocking active karst) or from point input recharge for contaminants. Mitigation measures to prevent these impacts from occurring are presented in **Section 10.6**. If implemented during the construction phase, these impacts will not occur during the operation phase.

During operation, potential groundwater quality impacts occur from the discharge of road runoff or from accidental spillages. Potential impacts of the discharge of routine road runoff is assessed in line with HD45/15 ‘Road Drainage and the water Environment’ Method C, while the assessment of accidental spillages is undertaken in **Chapter 10, Hydrology** line with HD45/15 'Road Drainage and the water Environment' Method D.

Within HD45/15, a Groundwater Protection Response (GPR) is presented which is a risk assessment methodology based on the vulnerability and aquifer classification of the aquifer where the discharge will occur. A matrix of these elements, presented below in **Table 10.21**, is used to determine the potential risk and sets out a series of 'Responses' that the drainage design of the proposed road development should comply with to minimise the risk to the groundwater environment. The assessment is considered a screening tool which can be superseded by a site specific hydrogeological risk assessment.

Table 10.21: Groundwater response matrix for the use of permeable drains in road schemes (TII, HD45/15, 2015)

Vulnerability rating	**Source protection area**	**Resource protection area (Aquifer category)**							
		Regionally Important Aquifer			**Locally Important Aquifer**			**Poor aquifer**	
		Rk*	**Rf**	**Rg**	**Lg**	**Lm**	**LI**	**PI**	**Pu**
Extreme: Rock near Surface or karst (X)	R4	R4	R4	R3(2)	R3(2)	R3(1)	R3(1)	R3(1)	R3(1)
Extreme €	R4	R2(3)	R2(2)	R3(2)	R3(2)	R2(2)	R2(2)	R2(1)	R2(1)
High (H)	R3(2)	R2(2)	R2(2)	R2(2)	R2(2)	R2(2)	R2(2)	R2(1)	R2(1)
Moderate (M)	R3(1)	R2(1)	R2(1)			R2(1)	R2(1)	R1	R1
Low (L)	R3(1)	R1	R1			R1	R1	R1	R1

*A small proportion of the country (~0.6%) is underlain by locally important karstic aquifers (Lk); in these areas, the groundwater protection responses for the Rk groundwater protection zone shall apply.

The Geological Survey of Ireland (GSI) provides mapped classifications of the aquifer and vulnerability criteria across the country, however it is recommended that the vulnerability criteria is updated based on site specific information.

Groundwater vulnerability assesses the geological and hydrogeological characteristics of the subsoil overlying the aquifer and provides a rating response using the TII HD45/15 GPR (**Table 10.21**). The GSI make a distinction between extreme vulnerability with bedrock at surface (X) and extreme vulnerability with subsoil being 0-3m thick (E). Where extreme (X) vulnerability refers to rock outcrop at surface or the location of a karst feature.

The groundwater protection response for the proposed road development is presented in **Appendix A.10.7** and concludes the following:

- Significant areas of the Galway Granite Batholith are identified by the GSI as being rock at or near surface. However, as most of the proposed road development is on embankment the groundwater vulnerability is mainly extreme (E). Those areas where groundwater vulnerability is extreme (X) are areas where the proposed road development is in cutting. In these areas the drainage design includes verges and swales that maintain a 1m constructed subsoil above bedrock. As the granite is of a low permeability infiltration to the bedrock is very low

- Drainage design for the Visean Undifferentiated Limestone is sealed up to the point of discharge, where to surface water or infiltration basin. Where discharge is proposed by infiltration basins then all locations have a GPR response of R2(3)
- Permeable drainage is acceptable for both R2(1) and R2(3) responses subject to subject to minimum Design Manual for Roads and Bridges (DMRB) standards and GPR Notes
- Permeable drainage is acceptable for the proposed road development where it traverses the Galway Granite Batholith subject to minimum DMRB conditions and GPR requirements 1,2 and 3. The design takes into account those ground receptors identified in **Section 10.3.4**. In the event of a vertical fault crosscutting the proposed road development then the drainage design will locally be sealed to prevent communication between flow zone and runoff
- Permeable drainage is acceptable for the proposed road development where it traverses the Visean Undifferentiated Limestone subject to minimum DMRB conditions and GPR requirements 1, 2, 3, 4, 5, 6 and 7. The drainage design takes into account karst primarily by avoidance but also by incorporating pre-treatment prior to discharge. Drainage design for the Visean Undifferentiated Limestone employs a sealed design with discharge either to surface water courses or infiltration basins. Where runoff discharges to surface water then there is no discharge to groundwater and a detailed hydrogeological assessment is not required. For those networks with discharge by infiltration basin then a hydrogeological assessment has been undertaken for each networks to assess the potential risks to groundwater. The individual assessments are included into **Appendix A.10.7**

On the basis of this hydrogeological assessment the design and measures of the infiltration basins assessed meet the criteria for HD45/15 for permeable drainage.

The potential impacts from accidental spillages have been assessed in line with TII Guidelines HD45/15 Method D. The potential risk of a serious pollution incident occurring has been calculated >1% and the calculations to confirm this are presented in **Chapter 10, Hydrology**.

The potential zone of influence for operation drawdown and water pollution impacts are presented in **Figure 10.8.101** to **Figure 10.8.114**.

10.5.4.1 Potential Impacts to groundwater resources

The potential impact assessment on the groundwater resources during the operation phase considers the impact that the changes in the groundwater regime and groundwater quality have on the aquifer.

In line with TII guidance, the magnitude of the impact on the aquifers within the study area is based on the portion of the aquifer that will be removed. This has been presented for the construction phase in **Section 10.5.3**, however it also applies here.

In summary, the volume of the aquifer is a very small percentage of the aquifer volume and for this reason, in line with TII rating, the Magnitude of the impact on the aquifers is 'Negligible' and the Significance of the impact is 'Imperceptible'.

The presence of the proposed road development itself can affect the aquifer by changing the recharge pattern to it. Details of the drainage design for the proposed road development are provided in **Chapter 5, Description of the Proposed Road Development**, which includes the surface areas of the proposed road development where recharge to the aquifer will not occur. Using this data, the surface area of the proposed road development is negligible when compared to the surface area of the land providing recharge to the aquifer. The Magnitude of the impact on the aquifer is 'Negligible' and the Significance of the impact is 'Imperceptible'.

Other impacts that have the potential to impact groundwater resources changing groundwater levels and changing water quality. The magnitude and significance of other impacts on the two aquifer types along the proposed road development is outlined in **Sections 10.5.4.1.1** and **10.5.4.1.2**.

10.5.4.1.1 Galway Granite Batholith (Section 1)

Based on the results presented in **Table 10.17** there are seven cuttings in the Galway Granite Batholith which have the potential to intersect the groundwater table locally. These road cuttings are EW01, EW02 (three cuttings), EW04, EW07 and EW11. As outlined in **Section 10.4**, EW11 has the largest ZoI with drawdown extending up to 54m from the edge of the footprint of the proposed road development.

The installation of drainage both for the proposed road development runoff and for pre-earthworks drainage will locally intercept drainage and for this reason, the conservative assumption is that the operational ZoI will mimic the construction ZoI for these excavations.

Other excavations which are included in the construction ZoI such as excavation for structures and attenuation ponds are relevant for construction only and hence the ZoI for operation will locally be reduced from the ZoI for construction.

Using the reported aquifer properties, the operation ZoI within the Galway Granite aquifer will yield relatively small volumes of groundwater, which will be managed on site and discharged to those nearby watercourses that the groundwater would contribute too indicating that there will be no net change to the volume of water in the aquifer. On this basis, in line with TII rating, the Magnitude of the impact of lowering the groundwater level on the aquifer is Negligible and the Significance of the impact is 'Imperceptible'.

Potential impacts to groundwater quality during operation occur from infiltration to ground from the proposed road runoff. The assessment of the infiltration of proposed road runoff for the Galway Granite Batholith is detailed in **Appendix A.10.7** and a summary is provided below.

The assessment of the operational discharges to ground is based on the TII HD45/15 GPR assessment which is based on the groundwater vulnerability and the aquifer type. For the Galway Granite Batholith, the GSI Groundwater vulnerability varies between extreme (X) and high (H) and the aquifer characterisation is poor (Pl). Based upon the design of the proposed road development with the mainline of the proposed road development on embankment or where in cutting verges and swales for over the edge drainage are proposed, the GPR returns a R2(1) response and meets TII HD45/15 guidelines. Due to the low hydraulic conductivity of the granite bedrock the potential impact to groundwater quality is local to the proposed road development. In line with TII guidance, the Magnitude of this potential impact on the aquifer is Moderate Adverse and the Significance of this impact is Significant / Moderate respectively. The duration of the impact is permanent.

If accidental spillages occur during the operation of the proposed road development, they have the potential to impact water quality. In line with TII guidance, the Magnitude of this potential impact is 'Moderate Adverse' and the Significance of this impact 'Significant / Moderate' respectively. The duration of such impacts will be brief, lasting less than one day.

10.5.4.1.2 Visean Undifferentiated Limestone (Section 2, 3 & 4)

During the operation phase of the proposed road development, there are thirteen sections in the Visean Undifferentiated Limestone Aquifer that remain in an open cutting or tunnel (see **Table 10.17**). This is two less than during construction as the River Corrib Bridge and Menlough Viaduct do not have excavations during operation.

The potential for impact is assessed on the basis of the depth of the cutting, including drainage, and the maximum groundwater levels monitored during the project specific ground investigation (2015-2017). Of these thirteen cuttings, six remain above the water table at all times and will not impact on groundwater levels. Seven cuttings do have the potential to intersect and impact on the water table locally during operation.

The seven cuttings/tunnel that have the potential to intersect the water table include three cuttings (EW27, EW34 and EW35), three tunnel approaches (EW19, EW30 and EW32) and two tunnels (EW20 Lackagh Tunnel and EW31 Galway Racecourse Tunnel). Both the Lackagh Tunnel and its western approach and the Galway Racecourse with its eastern approach will be sealed.

Based on the water level data collected for the proposed road development and the sealed design of the tunnels and their approaches the only excavations that have the potential to require operational dewatering of the bedrock aquifer are EW27, (Clare-Corrib GWB) EW34 and EW35 (Clarinbridge GWB).

The installation of drainage both for proposed road runoff and for pre-earthworks drainage will locally intercept drainage and for this reason, the conservative assumption is that the operational ZoI will mimic the construction ZoI for these three excavations. Based on the different aquifer properties for the various groundwater bodies outlined in the **Section 10.3.2**, the ZoI for drainage will be larger for the cuttings in the Clare-Corrib GWB than in the Clarinbridge GWB.

EW27 lies immediately west of the N83 Tuam Road and is a cutting where the proposed finished road level lies 10m above the summer groundwater level and 0.5m above the peak recorded winter groundwater level. As part of the design permanent drains will be installed to control the groundwater level 2m below the finished road level.

All groundwater intercepted by drains during the peak groundwater rise will be carried eastwards by unlined 150mm perforated pipes either side of the proposed road development with discharge along the pipe length and overflow to an infiltration basin. All groundwater intercepted by these drains will be discharged back into the groundwater body further east where groundwater levels are <5m below the proposed road level.

Within the Clarinbridge GWB the aquifer properties are relatively low and on this basis the volumes of groundwater to be generated during excavations are relatively small. Any groundwater lowering required will be kept within the same GWB so that groundwater volumes are maintained.

In the area of the Visean Undifferentiated Limestone there are few surface water features present. Where there is no option for discharge via surface water or storm water sewers the proposed road development will discharge to ground. As outlined in **Section 10.5.4** a hydrogeological assessment, in line with TII HD45/15 guidelines, was undertaken for the drainage design for discharges to ground. The full assessment is presented in **Appendix A.10.7** and is summarised below.

The design of the infiltration basin includes a 2m over excavation from the invert to place a 2m thick subsoil that will meet the TII definition of being an appropriate material (TII HD45/15). All of the infiltration basins are more than 15m from surface karst mapped during the karst survey (refer to **Figure 10.1.002**) and will be sealed up to the point of discharge. Additionally, all infiltration basins are designed to include the following features as standard design:

- A containment area
- A hydrocarbon interceptor
- A wetland

There is also a containment area in each drainage network that can manually be activated to contain spillage on the proposed carriageway.

Groundwater levels have been monitored along the route of the proposed road development between February 2015 and January 2017 in order to determine the seasonal variation in the groundwater level. On the basis of these measurements the minimum thicknesses of the saturated zone have been calculated for the infiltration basins and are presented in **Table 10.22**.

Table 10.22: Summary the unsaturated thicknesses below invert level for all infiltration basins

Network Ref	S19A	S19B	S20	S21A	S21B	S22A	S22B	S22C2	S22E	S40
Minimum unsaturated zone (m)	1.4	0.3	0	2.6	9.1	2.0	3.9	15.2	9.9	1.0

The groundwater level data shows significant seasonal variation locally and whilst all infiltration basins meet the requirement of 2m unsaturated zone during the groundwater low, infiltration basins S19a, S19b, S20 and S40 have less than 2m unsaturated zone during winter peaks. On this basis, infiltration basins at networks S21A, S21B, S22A, S22B, S22C2 and S22E meet and exceed the TII HD45/15 GPR criteria for R2(3) due to the pre-treatment.

Networks S19a, S19b, S20 and S40, however, do not meet the R2(3) criteria during the winter period when groundwater levels are elevated and there is less than 2m unsaturated zone (**Table 10.22**). However, as the standard design for infiltration basins for the proposed road development includes containment, a hydrocarbon interceptor and a wetland, then each infiltration basin includes significant pre-treatment of runoff prior to infiltration.

HD45/15 provides data on the event mean concentrations (EMC) of significant contaminants in routine runoff. The potential contaminants and their EMC are reproduced below in **Table 10.23**. The EMC data presented in TII HD45/15 is indicative of runoff water pre- treatment.

Table 10.23: Significant pollutants and their EMC

Determinand	Routine runoff Mean EMC µg/l
Total Copper	91.22
Dissolved Copper	31.31
Total Zinc	352.63
Dissolved Zinc	111.09
Total Cadmium	0.63
Total Fluoranthene	1.02
Total Pyrene	1.03
Total PAHs	7.52

As the pre-treatment aspect exceeds the requirements of HD45/15 for all infiltration basins then the treated run-off at infiltration basins S19a, S19b, S20 and S40 is of a higher quality than that listed in **Table 10.23**.

In addition to this, as noted in **Section 10.3.3** the maximum water levels were recorded during a period of unusually elevated groundwater levels following sustained rainfall events in the winter 2015/2016. Outside of these events, the minimum thickness requirement for the unsaturated zone will be present.

On this basis, the use of infiltration basins is assessed as being appropriate if no karst is encountered during construction of the excavation. Mitigation measures will be employed if karst is encountered during construction (refer to **Section 10.6**).

The presence of karst has been accommodated in the placement of the infiltration basins and no known active surface karst is present within 15m of any infiltration basin. However, there is a potential for karst to be encountered during the construction of infiltration basins and this is dealt with in the evaluation of construction impacts in **Section 10.5.3**.

The potential impact of karst is recognised as a significant aspect of the infiltration basins and is included in the mitigation measures of **Section 10.6**, which includes inspections to ensure that the infiltration basins remain in good working order for the operational life of the proposed road development.

Based on the TII HD45/15 Method C for groundwater protection response for routine runoff and site specific hydrogeological assessments the drainage design for operation of the proposed road development is considered to have an impact of negligible magnitude and imperceptible significance for all networks.

The potential accidental spillages to occur during the operation of the proposed road development, has the potential to impact on groundwater quality and has been assessed in line with TII HD45/15 Method C risk assessment. Based on the spillage risk assessment (refer to **Chapter 11, Hydrology**) the risk of a serious spillage occurring has an annual probability of less than 0.5% and is considered as acceptable based on TII guidelines.

In line with TII guidance, the Magnitude of this potential impact on the aquifer is negligible. The Significance of this impact on the Regionally Important is insignificant.

10.5.4.2 Potential Impacts to Groundwater supplies

An impact assessment on abstraction wells was completed for the construction phase and is presented in **Section 10.5.3.1**. The same assessment is valid for the operation phase. It highlights that five wells (W50-10, W50-11, W50-12, W50-13 and W12-14) will be removed by the proposed road development at the construction phase. One well (W1000-02) has been identified as lying downgradient and within the 100-day TOT from the proposed road development.

Mitigation measures for wells impacted outside of the proposed development boundary are proposed in **Section 10.6** and the residual impacts are summarised in **Section 10.7**.

10.5.4.3 Potential Impacts to Groundwater Dependent Terrestrial Ecosystems (GWDTE)

Potential impacts to GWDTE during operation derive from the interception of groundwater in cuttings and the deterioration of water quality from discharges and accidental spillages. A description of the specific locations where groundwater will be intercepted and where discharges will occur during operation of the proposed road development are detailed in **Section 10.5.4.1** for both the Galway Granite Batholith and the Visean Undifferentiated Limestone.

Based on the characteristics of the proposed road development **Section 10.4**. the zone of influence has been calculated for the operational passive dewatering of the bedrock aquifer. The zone of influence has been considered for those GWDTE listed in **Section 10.3.4.3** and the proximity for the operation ZoI to these GWDTE are presented in **Table 10.24**.

The water quality assessment of discharges from the proposed road development has been undertaken as part of TII HD45/15 groundwater protection response and individual hydrogeological assessments. The HD45/15 assessments conclude that the magnitude of the impact is 'Negligible' and the significance 'Imperceptible' for groundwater receptors (refer to **Section 10.5.4.1**). It should be noted that operational impacts are assessed on the basis of construction with guidance of the project karst protocol. In this regard, if karst was encountered during the construction of infiltration basins then these features would have been mitigated against at the construction phase.

Table 10.24: Summary of potential hydrogeological impacts at GWDTE during operation phase (pre-mitigation)

Feature	Impact to Groundwater Quantity	Impact to Groundwater Quality	Magnitude of Hydrogeology Impact	Significance of Hydrogeology Impact
European sites				
Galway Bay Complex cSAC	Localised rise in groundwater table below infiltration basins. Imperceptible net change to groundwater contribution	All discharges to groundwater are treated prior to infiltration	Negligible	Imperceptible
Inner Galway Bay SPA	Localised rise in groundwater table below infiltration basins. Imperceptible net change to groundwater contribution	All discharges to groundwater are treated prior to infiltration	Negligible	Imperceptible
Lough Corrib SPA	No European site lies upgradient	No European site lies upgradient	N/A	N/A
Lough Corrib cSAC	Localised rise in groundwater table below infiltration basin. Imperceptible net change to groundwater contribution	All discharges to groundwater are treated prior to infiltration	Negligible	Imperceptible

Feature	Impact to Groundwater Quantity	Impact to Groundwater Quality	Magnitude of Hydrogeology Impact	Significance of Hydrogeology Impact
Ballindooley Lough	No European site lies upgradient	No European site lies upgradient	N/A	N/A
National Heritage Sites				
Moycullen Bogs	No European site lies upgradient	No European site lies upgradient	N/A	N/A
Moycullen Bogs (Tonabrocky)	No European site lies upgradient	No European site lies upgradient	N/A	N/A
Moycullen Bogs (Letteragh)	No European site lies upgradient	No European site lies upgradient	N/A	N/A
Lough Corrib NHA	Localised rise in groundwater table below infiltration basin. Imperceptible net change to groundwater contribution	All discharges to groundwater are treated prior to infiltration	Negligible	Imperceptible
Galway Bay NHA	Localised rise in groundwater table below infiltration basin. Imperceptible net change to groundwater contribution	All discharges to groundwater are treated prior to infiltration	Negligible	Imperceptible
Annex I habitats (outside of SAC)				
Na Foraí Maola Thiar Ch. 0+650 to Ch. 0+750	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound
Na Foraí Maola Thoir Ch. 1+250 to Ch. 1+500	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound
Troscaigh Thiar (Ch. 1+850 to Ch. 2+400)	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound
Bearna (Ch. 2+600 to Ch. 3+100)	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound
Aille	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound

Feature	Impact to Groundwater Quantity	Impact to Groundwater Quality	Magnitude of Hydrogeology Impact	Significance of Hydrogeology Impact
(Ch. 3+300 to Ch. 3+900)				
Ballyburke (Ch. 4+800 to Ch. 5+900)	Within drawdown zone of influence	Within area liable to contamination	Large Adverse	Profound
NUI Galway (Ch. 8+800 to Ch. 8+950	No Outside of drawdown zone of influence	No discharges from road to ground	N/A	N/A
NUI Galway (Ch. 9+150 to Ch. 9+250	No Outside of drawdown zone of influence	No discharges from road to ground	N/A	N/A
Turlough K20 (Menlough North East)	No Outside of drawdown zone of influence	No (upgradient of proposed road)	N/A	N/A
Turlough K31 (Menlough East)	Localised rise in groundwater table below infiltration basin. Imperceptible net change to groundwater contribution	All discharges to groundwater are treated prior to infiltration	Negligible	Imperceptible
Turlough K72 (Coolagh North)	No Outside of drawdown zone of influence	No (upgradient of proposed road)	N/A	N/A
Petrifying Springs (Lackagh Quarry)	No Located above the groundwater table	No Located above the groundwater table	N/A	N/A
Local habitats				
Fen Ch. 7+850	Within ZoI	Drawdown will lower groundwater levels below the habitat	Large Adverse	Slight / Moderate
Calcareous springs (Lackagh Quarry)	No Located above the groundwater table	No Located above the groundwater table	N/A	N/A

Operation specific mitigation measures are presented in **Section 10.6**.

10.5.4.4 Potential Impacts to Groundwater Dependent Surface Water Features

Groundwater contributes to surface water at River Corrib, Ballindooley Lough, Coolagh Lakes, Turlough K20, Turlough K31, Turlough K72, Ballinfoyle Lough and Terryland River. It is noted that whilst the Eastern Coolagh Spring has the potential for groundwater contribution, Coolagh Lakes is not dependent on this spring. Coolagh Lakes is however dependent on the Western Coolagh Spring.

A zone of influence for drawdown has been calculated for both the Galway Granite Batholith and the Visean Undifferentiated Limestone. The design of the cutting carries any groundwater intercepted in cuttings and infiltrates back to ground within the same GWB. On this basis there is no net reduction to groundwater flow in each GWB. There are no operational groundwater impacts to surface water contribution.

10.5.4.5 Summary

The design of the proposed road development is cognisant of the hydrogeological existing environment and specifically groundwater receptors. Below is a summary of the design measures incorporated in the operation phase:

- Passive operational dewatering of the bedrock aquifer will be required within cuttings in the Galway Granite Batholith. Any intercepted groundwater will remain within its natural receiving catchment
- The drainage design in the Galway Granite Batholith is not sealed. Discharge of treated runoff will be to surface water. There will be small (<10%) losses of runoff (treated and untreated) to ground and these have no impact on groundwater quality beyond the footprint of the proposed road development
- Dewatering of the bedrock aquifer will not be undertaken in the catchment for Coolagh Lakes. This area of the proposed road development includes Menlough Viaduct and Lackagh Tunnel (including its approaches)
- Passive operational dewatering of the bedrock aquifer will be required in cutting EW27 but will only be operational during the seasonal groundwater peak. Any intercepted groundwater will remain within the GWB by being carried down gradient and recharged back to ground in an infiltration basin
- The design of the Galway Racecourse Tunnel and its eastern approach includes waterproofing to seal from groundwater ingress. The western approach includes groundwater interception (during peak winter only) which will drain westwards down gradient to an infiltration basin
- The drainage design of the proposed road development in the Undifferentiated Visean Limestone includes a sealed system and uses infiltration basins (operational phase) to discharge of treated runoff

Based on the design measures above each of the receptors have been assessed.

Table 10.25 below provides a summary of impact magnitude and impact significance for those hydrogeological receptors considered at risk during the operation phase. The assessment of ecological and surface water receptors refers only to the hydrogeology of each location (refer to **Chapter 8, Biodiversity** and **Chapter 11, Hydrology**).

Table 10.25: Summary of impact magnitude and significance for hydrogeological aspects of receptors at risk during the operation phase of the proposed road development

Feature	Importance of Hydrogeology Attribute	Hydrogeology Impact Summary	Hydrogeology Impact Magnitude	Hydrogeology Impact Significance
Groundwater resources				
Galway Granite Batholith (Pl)	Low	Permanent groundwater quality and quantity impacts	Negligible	Imperceptible
Visean Undifferentiated Limestone (Rkc)	Very High	Permanent groundwater quality and quantity impacts	Negligible	Imperceptible
Groundwater Supplies				
W50-10 (closed loop geothermal)	Low	Well will be lost	Large adverse	Slight/ moderate
W50-12	High	Well will be lost	Large adverse	Profound/ significant
W50-13 & W50-14	Very High	Well will be lost	Large adverse	Profound
W50-15	High	Well will be lost	Large adverse	Profound/ significant
W1000-2	Low	Well located downgradient from road	Large adverse	Slight/ moderate
Ecological Receptors				
Na Foraí Maola Thiar (Annex I habitat) Ch. 0+650 to Ch. 0+750	Proposed road development traverses the habitat	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater levels below the habitat	Large Adverse	Profound
Na Foraí Maola Thoir (Annex I habitat) Ch. 1+250 to Ch. 1+500	Proposed road development traverses the habitat	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater	Large Adverse	Profound

Feature	Importance of Hydrogeology Attribute	Hydrogeology Impact Summary	Hydrogeology Impact Magnitude	Hydrogeology Impact Significance
		levels below the habitat		
Troscaigh Thiar (Annex I habitat) (Ch. 1+850 to Ch. 2+400)	Proposed road development traverses the habitat	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater levels below the habitat	Large Adverse	Profound
Aille (Annex I habitat) (Ch. 3+300 to Ch. 3+900)	Proposed road development traverses the habitat	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater levels below the habitat	Large Adverse	Profound
Ballyburke (Annex I habitat) (Ch. 4+800 to Ch. 5+900)	Proposed road development traverses the habitat	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater levels below the habitat	Large Adverse	Profound
Unnamed Fen (Locally important) Ch. 7+850	Unnamed Fen (Locally important) Ch. 7+850	Within calculated drawdown zone of influence Drawdown will permanently lower groundwater levels below the habitat	Large Adverse	Slight / moderate
Surface water				
(No operational impacts)				

10.6 Mitigation Measures

10.6.1 Introduction

This section describes the measures to mitigate the potential impacts for both the construction (**Section 10.6.2**) and operational phases (**Section 10.6.3**) of the proposed road development.

In order to protect receptors identified in **Section 10.3.4**, both in terms of groundwater resources and water quality, mitigation measures will be put in place during the construction and operational phases of the proposed road development.

Through the evolution of the design of the proposed road development measures were included in the design to reduce or avoid specific impacts where possible. Following the evaluation of potential impacts as a result of the design, specific mitigation measures have been developed to avoid, prevent, reduce and, if possible, remedy any significant adverse impacts on hydrogeology. These are described below.

10.6.2 Construction Phase

The measures listed below will be adopted during the construction phase of the proposed road development.

The following measures were incorporated into the design (refer to **Section 10.5**) of the proposed road development:

- No dewatering of the bedrock aquifer will occur during construction at Menlough Viaduct or Lackagh Tunnel (or its approaches). Furthermore, the construction sequence will take into account the seasonal groundwater fluctuation. During the winter groundwater high it may be necessary to limit the depth of works so that dewatering of the bedrock aquifer is not required
- Galway Granite Batholith EW01, 02 (three cuttings), 04, 07 and 09: Groundwater intercepted will be collected and piped to the surface water receptor it would naturally have drained to
- Limestone: Construction dewatering of the bedrock aquifer may seasonally be required in EW27 during peak groundwater levels. Any dewatering will be discharged to the same GWB.
- Construction of the Galway Racecourse Tunnel and its approaches will require dewatering of the bedrock aquifer. All groundwater intercepted will be managed and discharged within the same GWB
- EW27: Groundwater will be controlled within the excavation by collection in drains or sumps. If groundwater is intercepted, it will be piped and discharged at an infiltration basin within the same GWB. Intercepted groundwater is controlled and infiltrates back to the same groundwater body
- Where infiltration basins are used for discharge of site runoff during construction the runoff will be managed on site, collected and treated as per the

Sediment Erosion and Pollution Control Plan (Refer to Section 8 of the CEMP in **Appendix A.7.5**).

The design of the proposed road development includes dewatering of the bedrock aquifer in cuttings in the Galway Granite Batholith and in cuttings in the Visean Undifferentiated Limestone. The drawdown from these cuttings has been assessed. Drawdown impacts are limited in extent and do not impact on European sites or National Heritage Areas. No hydrogeological mitigation is proposed with regard to the design of construction dewatering.

For the Visean Undifferentiated Limestone due to the risk of karst features being intercepted in excavations for earthworks (including viaducts, bridges and tunnels) and infiltration basins, mitigation measures have been developed to preserve the hydraulic connectivity of the feature and then seal it from the excavation. The Karst Protocol mitigation measure will ensure that there is no impact on groundwater flow paths to water dependant receptors. The Karst mitigation plan is detailed in the Construction Environmental Management Plan (CEMP) (**Appendix A.7.5**) and is summarised below in **Section 10.6.2.2.1** Aquifer Specific Mitigation Measures.

Those infiltration basins in the Lough Corrib Fen 1 (Menlough) GWB (S19a and S19b) shall have additional measures incorporated into their construction to provide further protection to the groundwater body. Infiltration basin S19a and S19b include lining the sides of the excavation to ensure vertical groundwater infiltration so that all discharges drain through the placed subsoil for the full thickness of the unsaturated zone.

10.6.2.1 Standard Mitigation Measures

Mitigation of potential construction impacts will be achieved through the stringent implementation of good construction practice procedures and environmental controls so as minimise the opportunity for contaminated releases of construction runoff as set out in the CEMP (**Appendix A.7.5**). Such practices will include adequate bunding for oil containers, wheel washers and dust suppression on site roads, and regular plant maintenance.

The following measures included in the CEMP will be implemented to control the potential for pollution from accidental spillages on site:

- Stockpiling of contaminated material is not permitted
- Good housekeeping (daily site clean-ups, use of disposal bins, etc.) on the site during construction, and the proper use, storage and disposal of these substances and their containers will prevent groundwater contamination
- For all activities involving the use of potential pollutants or hazardous materials, under the CEMP, the contractor will be required to ensure that material such as concrete, fuels, lubricants and hydraulic fluids will be carefully handled and stored to avoid spillages. Potential pollutants shall also be adequately secured against vandalism and will be provided with proper containment according to codes of practice. Any spillages will be immediately contained and contaminated soil removed from the site and properly disposed of

- The contractor will finalise the Incident Response Plan in the CEMP in **Appendix A.7.5** prior to work commencing and regularly update it for pollution emergencies which will be developed by the appointed contractor. The plan identified the actions to be taken in the event of a pollution incident. As recommended in the CIRIA document, the contingency plan for pollution emergencies includes the following:
    - Containment measures
    - Emergency discharge routes
    - List of appropriate equipment and clean-up materials
    - Maintenance schedule for equipment
    - Details of trained staff, location and provision for 24-hour cover
    - Details of staff responsibilities
    - Notification procedures to inform the Environmental Protection Agency (EPA) or environmental department of the Galway County Council
    - Audit and review schedule
    - Telephone numbers of statutory water consultees
    - List of specialist pollution clean-up companies and their telephone numbers
    - No direct untreated point discharge of construction runoff to groundwater will be permitted
    - Where a pollution incident is detected, construction works will be stopped until the source of the construction pollution has been identified and remedied
    - Pollution control facilities and procedures set out in the Sediment, Erosion and Pollution Control Construction Management Plan included in the CEMP will be implemented if required
    - The pollution control and treatment facilities will be installed and the monitoring network including instrumentation and procedures established prior to construction activities taking place on the ground in the vicinity of watercourses and sensitive surface and groundwater receptors. It is envisaged that the pollution control facilities will be monitored daily to ensure their continued function

10.6.2.2 Receptor specific mitigation measures

A number of mitigation measures have been developed specifically for groundwater dependent receptors. These are detailed below for aquifer, supply wells and habitats.

10.6.2.2.1 Aquifer Specific Mitigation Measures

Aquifer specific mitigation measures are implemented where karst or high permeability zones are encountered during the construction programme.

In the event of karst being encountered the Karst Protocol shall be implemented, which is documented in the CEMP (**Appendix A.7.5**). Application of the Karst Protocol are summarised below to detail where they will be implemented:

- Where karst features are encountered during construction works these will be assessed by a hydrogeologist and an engineering geologist. These features will require their extent across the proposed road development to be delineated. In the case of excavations (road cuttings, tunnels, bridge pier excavations) then the karst feature shall be excavated and backfilled with course fill and sealed. This will prevent runoff draining into the feature and therefore protect against accidental spillage. On this basis, construction runoff will not discharge to a karst pathway and will receive natural attenuation and dilution in the aquifer

- With regard to karst features being intercepted in excavations for earthworks (including viaducts, bridges and tunnels) and infiltration basins. The Karst Protocol preserves the hydraulic connectivity of the feature using granular material to fill but then seals the karst from the excavation using a liner (geotextile and or concrete depending on the site specifics) that will prevent linkage between excavation and the karst
- Where dewatering of the bedrock aquifer is proposed, groundwater level monitoring will be installed before construction, during the construction phase and 12 months following construction to enable potential effects from dewatering to be identified. In the shallow cuts of the proposed road development there will be minimal dewatering of the bedrock aquifer required; nonetheless, a monitoring programme will be in place. If the monitoring indicates there is a measureable impact beyond that stated in this EIAR, then work with the potential to increase drawdown will be made safe and cease until the hydrogeological assessment is revised based on the site conditions and mitigation employed if appropriate
- In order to reduce potential contamination impacts, stockpiling of contaminated material and leachate generation will be prohibited. In the situation that potential contaminated material is encountered it will be tested and disposed of in an appropriate manner and in line with current water management legislation. If it is not possible to immediately remove contaminated material, then it will be stored on, and covered by, polythene sheeting to prevent rain water infiltrating through the material. The time frame between excavation and removal will be kept to an absolute minimum

10.6.2.2.2Mitigation measures specific for supply wells

The mitigation measures listed below will be adopted during the construction phase of the proposed road development:

- Five wells (W50-10, W50-12, W50-13, W50-14 and W50-15) will be lost during the construction of the proposed road development. These will each be mitigated by providing a replacement well, connecting to mains supply where available or by financial compensation. Where wells have to be abandoned as part of the proposed road development they will be sealed and abandoned in general accordance with Well Drilling Guidelines produced by the Institute of Geologists of Ireland (IGI 2007)
- Replacement wells, storage tank, associated pumping equipment and pipework for Wells W50-13 and W50-14 will be commissioned and tested to ensure adequate yield rates in advance of wells W50-13 and W50-14 being decommissioned.

- Wells outside of the proposed development boundary but within the drawdown zone of influence may be impacted by reduced groundwater levels during construction. All wells within 150m of the proposed development boundary (or 50m from the calculated drawdown ZoI if greater) will be monitored for water level on a monthly basis for 12 months before construction, during construction and for 12 months after construction. If the monitoring indicates that the proposed road development has impacted on a supply or geothermal well then mitigation will be applied
- Standard mitigation measures and aquifer specific mitigation measures are employed for protection of groundwater. To ensure the protection of quality of groundwater potable supplies, all wells within 150m of the proposed development boundary will be monitored for water quality on a monthly basis. All wells will be monitored for standard drinking water quality parameters on a monthly basis for 12 months before construction, during construction and for 12 months after construction. If the monitoring indicates that the proposed road development has impacted on a supply, then mitigation will be applied

10.6.2.2.3 Specific Mitigation measures for GWDTE

As presented in **Section 10.3.4** the proposed road development traverses groundwater bodies that supply a number of GWDTE. Those GWDTE that have been flagged as being at risk are all in areas where the groundwater pathways are karstic. In this regard the Karst Protocol, as detailed above in **Section 10.6.2.2.1**, forms part of mitigation to prevent groundwater quality or quantity being impacted. Additional mitigation is also employed to ensure that European sites are not impacted.

Construction activities represent a potential source of impact on the water quality of the Coolagh Lakes, which form part of the Lough Corrib cSAC, from uncontrolled construction site runoff and potential contamination of the groundwater from construction spillages. There will be no surface water discharges to the Coolagh lakes and all runoff will be treated before being discharged to ground at infiltration basins. Infiltration basins are designed to include settlement to remove sediment and have an appropriate thickness of subsoil below invert level.

Pouring of the concrete in excavations (River Corrib Bridge, Menlough Viaduct and Lackagh Tunnel) will only be undertaken when the excavation has been inspected by a qualified hydrogeologist. Inspection of the full depth and extent of each excavation will be undertaken to identify if any significant flow paths, such as the karst enhancement of the bedrock permeability, are present. If no significant flow paths are present, then the hydrogeologist will document accordingly and confirm that there is no risk to groundwater from concrete leakage. If significant pathways are present then impacts which may arise from flow along these pathways shall be designed by the hydrogeologist based on the karst mitigation plan, these may comprise of installing a high permeability zone to replace the groundwater pathways which would be removed by the foundations and / or sealing the linkage from excavation to protect the karst. The design of the mitigation measures shall be approved by a qualified hydrogeologist to confirm that there will be no negative impacts to groundwater.

These above measures will ensure that the risk of pollution of groundwater bodies is controlled. These mitigation measures are employed during construction, the impacts on groundwater quality beneath the site will be of Negligible Magnitude and Imperceptible Significance.

10.6.3 Operational Phase

During the operational phase of the proposed road development inspection and maintenance will occur to ensure that the infiltration basins continue to operate as intended for the design life of the proposed road development. A number of measures were incorporated into the design of the proposed road development to minimise their impact. These have been included in **Section 10.5.4** above and are repeated here for clarity.

In the drainage design, the infiltration basin design uses over excavation below the design invert to place subsoil of an appropriate thickness and material that meets TII Guidelines (TII HD45/15). All of the infiltration basins are more than 15m from surface karst mapped during the karst survey (refer to **Figure 10.1.002**) and will have sealed drainage up to the point of infiltration. All infiltration basins are designed to include the following features:

- A containment area
- A hydrocarbon interceptor
- A wetland

There is also a containment area in each drainage network that can manually be activated to contain spillage on the carriageway.

Networks S19a, S19b and S41 are located on the Lough Corrib Fen 1 (Menlough) GWB, which supports groundwater dependant terrestrial ecosystems (GWDTE) at Coolagh lakes. Due to the sensitivity of the Lough Corrib Fen 1 (Menlough) GWB those drainage networks that drain the carriageway above the GWB, which include S19a and S19b, also have a liner installed to ensure that the treated run-off percolates through the full thickness of the subsoil. S41 is located on a side road with a lower risk of accidental spillage and as such does not include this mitigation measure.

Infiltration basins require regular inspection to confirm that no observable subsidence in the infiltration has occurred due to karst. There are no guidelines on the inspection frequency for infiltration basins, however, based on the mitigation measures implemented the risk of subsidence occurring is considered to be low and inspection is recommended on 5-year frequency.

If karst features and potential pathways are found to be present during inspection, then the Karst Protocol developed for the construction phase will be implemented to ensure that no preferential pathways have formed within the infiltration basin.

10.7 Residual Impacts

The residual impacts are those that will occur after the proposed mitigation measures have taken effect and are shown in **Table 10.26** and **Table 10.27** below. There are no residual hydrogeological impacts to European sites.

Residual hydrogeological impacts remain for groundwater level drawdown impacts below the location of five Annex I habitats on the Galway Granite Batholith.

Table 26: Summary of hydrogeological residual impacts to receptors during the construction phase

Constraint	Importance		Construction Phase					
Name	**Ranking**	**Justification**	**Magnitude of Hydrogeology Impact**	**Criteria for Hydrogeology Impact Assessment**	**Significance of Hydrogeology Impact**	**Mitigation Measure**	**Residual Hydrogeology Impact Magnitude**	**Residual significance of Hydrogeology impact**
Groundwater resources and supplies								
Poor Bedrock Aquifer	Low	Poor Bedrock Aquifer	Negligible	A small proportion of the aquifer is being removed	Imperceptible	N/A	Negligible	Imperceptible
Regionally Important Aquifer	Very High	Regionally Important Aquifer	Negligible	A small proportion of the aquifer is being removed	Imperceptible	N/A	Negligible	Imperceptible
Knocknacarra GWS (W50-01)	Medium	Group water scheme supplying approximately 50 houses	No Impact	NA	N/A	N/A	N/A	N/A
W50-02	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W50-03 04, 05, 06 and 07	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W50-08	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A

Constraint	Importance		Construction Phase					
Name	**Ranking**	**Justification**	**Magnitude of Hydrogeology Impact**	**Criteria for Hydrogeology Impact Assessment**	**Significance of Hydrogeology Impact**	**Mitigation Measure**	**Residual Hydrogeology Impact Magnitude**	**Residual significance of Hydrogeology impact**
W50-09	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W50-10	Low	Domestic geothermal well	Large adverse	Will be decommissioned as part of works	Profound/ Significant	Replace / compensate	N/A	N/A
W50-11	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W50-12	Low	Commercial supply	Large adverse	Will be decommissioned as part of works	Profound/ Significant	Replace / compensate	N/A	N/A
W50-13 & 14	Low	Commercial supply	Large adverse	Will be decommissioned as part of works	Profound	Replace	N/A	N/A
W50-15	Low	Commercial supply	Large adverse	Will be decommissioned as part of works	Profound/ Significant	Replace / compensate	N/A	N/A

Constraint	Importance		Construction Phase					
Name	**Ranking**	**Justification**	**Magnitude of Hydrogeology Impact**	**Criteria for Hydrogeology Impact Assessment**	**Significance of Hydrogeology Impact**	**Mitigation Measure**	**Residual Hydrogeology Impact Magnitude**	**Residual significance of Hydrogeology impact**
W100-01 & 02	Low	Agricultural supply and / or Domestic supply	No Impact	N/A	N/A	N/A	N/A	N/A
W100-03, 04, 05 and 06	Low	Agricultural supply and / or Domestic supply	No Impact	N/A	N/A	N/A	N/A	N/A
W500-01	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W1000-01	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W1000-02	Low	Agricultural supply and / or Domestic supply	Moderate adverse	Within ZoI for areas of potential pollution	Slight	Well will be monitored for water level and quality as within 150m of fence line	N/A	N/A
W1000-03	Low	Agricultural supply and / or Domestic supply	No Impact	N/A	N/A	N/A	N/A	N/A
W1000-04	Low	Agricultural supply and / or Domestic supply	No Impact	N/A	N/A	N/A	N/A	N/A

Constraint	Importance		Construction Phase					
Name	**Ranking**	**Justification**	**Magnitude of Hydrogeology Impact**	**Criteria for Hydrogeology Impact Assessment**	**Significance of Hydrogeology Impact**	**Mitigation Measure**	**Residual Hydrogeology Impact Magnitude**	**Residual significance of Hydrogeology impact**
G50-01	Low	Closed loop geothermal well	No impact	N/A	N/A	Well will be monitored for water level as within 150m of fence line	N/A	N/A
Groundwater dependent habitats								
Galway Bay Complex cSAC	Extremely High	European site	Negligible	GWB with risk of impact is very small contributor to receiving water	Insignificant	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant
Inner Galway Bay SPA	Extremely High	European site	Negligible	GWB with risk of impact is very small contributor to receiving water	Insignificant	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant
Lough Corrib cSAC	Extremely High	European site	Large adverse	GWB with risk of impact is main contributor to receiving	Profound	CEMP inc. karst protocol, runoff management	Negligible	Insignificant

Constraint	Importance		Construction Phase					
Name	**Ranking**	**Justification**	**Magnitude of Hydrogeology Impact**	**Criteria for Hydrogeology Impact Assessment**	**Significance of Hydrogeology Impact**	**Mitigation Measure**	**Residual Hydrogeology Impact Magnitude**	**Residual significance of Hydrogeology impact**
				water at Coolagh Lakes		and pollution control		
Lough Corrib SPA	Extremely High	European site	No impact	N/A	N/A	N/A	N/A	N/A
Ballindooley Lough	Very High	Support to European site	No Impact	N/A	N/A	N/A	N/A	N/A
Moycullen Bogs	Very High	Site of national importance	No Impact	N/A	N/A	N/A	N/A	N/A
Lough Corrib NHA	Very High	Site of national importance	Large adverse	GWB with risk of impact is main contributor to receiving water at Coolagh Lakes	Significant	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant
Galway Bay NHA	Very High	Site of national importance	Negligible	GWB with risk of impact is very small contributor to receiving water	Insignificant	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant

Constraint	Importance		Construction Phase					
Name	**Ranking**	**Justification**	**Magnitude of Hydrogeology Impact**	**Criteria for Hydrogeology Impact Assessment**	**Significance of Hydrogeology Impact**	**Mitigation Measure**	**Residual Hydrogeology Impact Magnitude**	**Residual significance of Hydrogeology impact**
Na Foraí Maola Thiar (Ch. 0+650 to Ch. 0+750)	Very High	Annex 1 Habitat	Large Adverse	Within ZoI for dewatering of the bedrock aquifer and downgradient of site	Profound	CEMP	Large adverse	Profound
Na Foraí Maola Thoir (Ch. 1+250 to Ch. 1+500)	Very High	Annex 1 Habitat	Large Adverse	Within ZoI for dewatering of the bedrock aquifer and downgradient of site	Profound	CEMP	Large adverse	Profound
Troscaigh Thiar (Ch. 1+850 to Ch. 2+400)	Very High	Annex 1 Habitat	Large Adverse	Within ZoI for dewatering of the bedrock aquifer and downgradient of site	Profound	CEMP	Large adverse	Profound
Aille (Ch. 3+300 to Ch. 3+900)	Very High	Annex 1 Habitat	Large Adverse	Within ZoI for dewatering of the bedrock aquifer and downgradient of site	Profound	CEMP	Large adverse	Profound

Constraint	**Importance**		**Construction Phase**					
Name	**Ranking**	**Justification**	**Magnitude of Hydrogeology Impact**	**Criteria for Hydrogeology Impact Assessment**	**Significance of Hydrogeology Impact**	**Mitigation Measure**	**Residual Hydrogeology Impact Magnitude**	**Residual significance of Hydrogeology impact**
Ballyburke (Ch. 4+800 to Ch. 5+900)	Very High	Annex 1 Habitat	Large Adverse	Within ZoI for dewatering of the bedrock aquifer and downgradient of site	Profound	CEMP	Large adverse	Profound
NUI Galway (Ch. 8+800 to Ch. 8+950	Very High	Annex 1 Habitat	None	Upgradient	N/A	N/A	N/A	N/A
NUI Galway (Ch. 9+150 to Ch. 9+250	Very High	Annex 1 Habitat	Moderate adverse	Downgradient of site	Moderate / adverse	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant
Turlough K20 (Menlough North East)	Very High	Annex 1 Habitat	None	N/A	N/A	N/A	N/A	N/A
Turlough K31 (Menlough East)	Very High	Annex 1 Habitat	Large adverse	Downgradient of site	Profound	CEMP inc. karst protocol, runoff management	Negligible	Insignificant

Constraint	Importance		Construction Phase					
Name	**Ranking**	**Justification**	**Magnitude of Hydrogeology Impact**	**Criteria for Hydrogeology Impact Assessment**	**Significance of Hydrogeology Impact**	**Mitigation Measure**	**Residual Hydrogeology Impact Magnitude**	**Residual significance of Hydrogeology impact**
						and pollution control		
Turlough K72 (Coolagh North)	Very High	Annex 1 Habitat	None	N/A	N/A	N/A	N/A	N/A
Petrifying Springs (Lackagh Quarry)	Very High	Annex 1 Habitat	Negligible	Located above groundwater table	Insignificant	Rock bolting used but no concreting	Negligible	Insignificant
Fen Ch. 7+850	Low	Site of local importance	Large adverse	Within ZoI for dewatering of the bedrock aquifer and downgradient of site	Slight / Moderate	CEMP	Large adverse	Slight/ Moderate
Calcareous springs (Lackagh Quarry)	Low	Site of local importance	Negligible	Located above groundwater table	Insignificant	Rock bolting used but no concreting	Negligible	Insignificant
Groundwater dependent surface water features								
Terryland River	Extremely High	Supporting feature for Lough Corrib cSAC	Small adverse	GWB with risk of impact is small contributor to receiving water	Significant	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant

Table 27: Summary of hydrogeological residual impacts to receptors during the operational phase

Constraint	**Importance**		**Operational Phase**					
Name	**Ranking**	**Justification**	**Magnitude of Hydrogeology Impact**	**Criteria for Hydrogeology Impact Assessment**	**Significance of Hydrogeology Impact**	**Mitigation Measure**	**Residual Hydrogeology Impact Magnitude**	**Residual significance of Hydrogeology impact**
Groundwater resources and supplies								
Poor Bedrock Aquifer	Low	Poor Bedrock Aquifer	Negligible	A small proportion of the aquifer is being removed	Imperceptible	None	Negligible	Imperceptible
Regionally Important Aquifer	Very High	Regionally Important Aquifer	Negligible	A small proportion of the aquifer is being removed	Imperceptible	None	Negligible	Imperceptible
Knocknacarra GWS (W50-01)	Medium	Group water scheme supplying approximately 50 houses	No Impact	NA	N/A	N/A	N/A	N/A
W50-02	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W50-03 04, 05, 06 and 07	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W50-08	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A

Constraint	Importance		Operational Phase					
W50-09	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W50-10	Low	Domestic geothermal well	Large adverse	Will be decommissioned as part of works	Profound / Significant	Replace / compensate	N/A	N/A
W50-11	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W50-12	Low	Commercial supply	Large adverse	Will be decommissioned as part of development	Profound / Significant	Replace / compensate	N/A	N/A
W50-13 & 14	Low	Commercial supply	Large adverse	Will be decommissioned as part of development	Profound	Replace	N/A	N/A
W50-15	Low	Commercial supply	Large adverse	Will be decommissioned as part of development	Profound/ Significant	Replace / compensate	N/A	N/A
W100-01 & 02	Low	Agricultural supply and / or Domestic supply	No Impact	N/A	N/A	N/A	N/A	N/A
W100-03, 04, 05 and 06	Low	Agricultural supply and / or Domestic supply	No Impact	N/A	N/A	N/A	N/A	N/A

Constraint	Importance		Operational Phase					
W500-01	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W1000-01	Low	Agricultural supply and / or Domestic supply	No Impact	NA	N/A	N/A	N/A	N/A
W1000-02	Low	Agricultural supply and / or Domestic supply	Moderate adverse	Within 150m of fence line	Slight	Well will be monitored for water level and quality as within 150m of fence line	Moderate adverse	Slight
W1000-03	Low	Agricultural supply and / or Domestic supply	No Impact	N/A	N/A	N/A	N/A	N/A
W1000-04	Low	Agricultural supply and / or Domestic supply	No Impact	N/A	N/A	N/A	N/A	N/A
G50-01	Low	Closed loop geothermal well	No impact	N/A	N/A	Well will be monitored for water level as within 150m of fence line	N/A	N/A
Groundwater dependent habitats								
Galway Bay Complex cSAC	Extremely High	European site	Negligible	Meets HD45/15	Insignificant	CEMP inc. karst	Negligible	Insignificant

Constraint	Importance		Operational Phase					
						protocol, runoff management and pollution control		
Inner Galway Bay SPA	Extremely High	European site	Negligible	Meets HD45/15	Insignificant	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant
Lough Corrib cSAC	Extremely High	European site	Negligible	Meets HD45/15	Insignificant	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant
Lough Corrib SPA	Extremely High	European site	No impact	N/A	N/A	N/A	N/A	N/A
Ballindooley Lough	Very High	Support to European site	No Impact	N/A	N/A	N/A	N/A	N/A
Moycullen Bogs	Very High	Site of national importance	No Impact	N/A	N/A	N/A	N/A	N/A

Constraint	**Importance**		**Operational Phase**					
Lough Corrib NHA	Very High	Site of national importance	Negligible	Meets HD45/15	Insignificant	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant
Galway Bay NHA	Very High	Site of national importance	Negligible	Road runoff is treated prior to infiltration	Insignificant	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant
Na Foraí Maola Thiar (Ch. 0+650 to Ch. 0+750)	Very High	Annex 1 Habitat	Large Adverse	Within ZoI for dewatering of the bedrock aquifer and downgradient of site	Profound	CEMP	Large adverse	Profound
Na Foraí Maola Thoir (Ch. 1+250 to Ch. 1+500	Very High	Annex 1 Habitat	Large Adverse	Within ZoI for dewatering of the bedrock aquifer and downgradient of site	Profound	CEMP	Large adverse	Profound

Constraint	Importance		Operational Phase					
Troscaigh Thiar (Ch. 1+850 to Ch. 2+400)	Very High	Annex 1 Habitat	Large Adverse	Within ZoI for dewatering and downgradient of the bedrock aquifer of site	Profound	CEMP	Large adverse	Profound
Aille (Ch. 3+300 to Ch. 3+900)	Very High	Annex 1 Habitat	Large Adverse	Within ZoI for dewatering of the bedrock aquifer and downgradient of site	Profound	CEMP	Large adverse	Profound
Ballyburke (Ch. 4+800 to Ch. 5+900)	Very High	Annex 1 Habitat	Large Adverse	Within ZoI for dewatering of the bedrock aquifer and downgradient of site	Profound	CEMP	Large adverse	Profound
NUI Galway (Ch. 8+800 to Ch. 8+950	Very High	Annex 1 Habitat	None	Upgradient	N/A	N/A	N/A	N/A
NUI Galway (Ch. 9+150 to Ch. 9+250	Very High	Annex 1 Habitat	Moderate adverse	Downgradient of site	Moderate / adverse	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant

Constraint	Importance		Operational Phase					
Turlough K20 (Menlough North East)	Very High	Annex 1 Habitat	None	N/A	N/A	N/A	N/A	N/A
Turlough K31 (Menlough East)	Very High	Annex 1 Habitat	Large adverse	Downgradient of site	Profound	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant
Turlough K72 (Coolagh North)	Very High	Annex 1 Habitat	None	N/A	N/A	N/A	N/A	N/A
Petrifying Springs (Lackagh Quarry)	Very High	Annex 1 Habitat	Negligible	Located above groundwater table	Insignificant	Rock bolting used but no concreting	Negligible	Insignificant
Fen Ch. 7+850	Low	Site of local importance	Large adverse	Within ZoI for dewatering of the bedrock aquifer and downgradient of site	Slight/ Moderate	CEMP	Large adverse	Slight/ Moderate
Calcareous springs (Lackagh Quarry)	Low	Site of local importance	Negligible	Located above groundwater table	Insignificant	Rock bolting used but no concreting	Negligible	Insignificant

Constraint	**Importance**		**Operational Phase**					
Groundwater dependent surface water features								
Terryland River	Extremely High	Supporting feature for Lough Corrib cSAC	Small adverse	GWB with risk of impact is small contributor to receiving water	Significant	CEMP inc. karst protocol, runoff management and pollution control	Negligible	Insignificant

10.7.1 Cumulative Impacts

Cumulative impacts are defined as the combination of many minor impacts creating one, larger, more significant impact (NRA, 2009 and EPA 2017). Cumulative impacts consider existing stresses on the natural environment as well as developments that are underway and in planning.

The baseline hydrogeology has identified that the groundwater bodies in the study area have a number of existing stresses in the form of discharges from wastewater treatment systems, septic tanks, road runoff, quarrying and agriculture. These potential pollutant sources have the potential to impact the groundwater environment in the form of reducing water quality by increased contaminants. On the basis of the design and mitigation measures employed for the proposed road development accommodate and maintain the existing GWB sub-catchments then there will be no alteration of groundwater pathways that could modify the impacts from existing pollutant sources.

The following developments being constructed or in planning are considered in terms of the cumulative hydrogeological impact with the proposed road development.

- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS)

The zone of influence from the N59 Maam Cross to Oughterard Road Project and N17/N18 projects occurs within separate groundwater sub catchments to those identified for the proposed road development and as such any impacts from these projects will not impact on the groundwater systems that the proposed road development straddles.

The proposed Galway Harbour Port Extension is located within the same GWB sub-catchment as the proposed road development but is located significantly downgradient of the proposed road development in transition coastal waters.

The Galway Transport Strategy includes some realignment of local roads but these do not incorporate cuttings or structures that could impact on groundwater.

The cumulative impact of the proposed road development with existing stresses on the hydrogeological environment and those in development or in planning has been considered. On the basis of the design and mitigation measures employed for the proposed road development there will be no alteration of groundwater pathways and hence no enhanced impact from existing pollutant sources within groundwater bodies. Furthermore, those new developments being constructed or proposed are located in different GWB sub catchments or located significantly downgradient so as not to cumulate impacts.

On this basis the cumulative impacts of the above developments with the proposed road development is negligible.

10.8 Summary

The hydrogeological study area is divided into two main areas on the basis of the contrasting aquifer properties for the two main geological rock types in the region; the Galway Granite Batholith in the west and the Visean Undifferentiated Limestone in the east.

In the western section underlain by granite is a poor aquifer that is only productive in local zones. The combination of poor aquifer and blanket bog cover, where rock is not exposed, limits the quantity of recharge that can infiltrate to ground. The groundwater table remains close to the surface and generally follows topography. The area is divided into two groundwater bodies the Spiddal GWB, which drains to Galway Bay and the Maam-Clonbur GWB which drains to the River Corrib. Groundwater flow in the Galway Granite Batholith is isolated to weathered zones and fracture zones and pathways generally tend to be up to 100m.

In the eastern section the Visean Undifferentiated Limestone is a regionally important karstified aquifer, which is dominated by conduit flow. The aquifer is capable of supplying regionally important abstractions and is associated with the presence of karst landforms and features but also the relatively low abundance of surface water features and man-made drainage. The Visean Undifferentiated Limestone is subdivided into groundwater bodies; Lough Corrib Fen 1 (Menlough), Lough Corrib Fen 3 & 4, Clarinbridge, Clare-Corrib and Ross Lake. Features within the groundwater bodies, including Coolagh Lakes, Ballindooley Lough and the Terryland River are located on valley fill which cause the features to become perched during low groundwater levels.

Groundwater receptors have been identified in both sections and include groundwater resources, groundwater abstractions, groundwater dependent habitat and groundwater dependent surface water features.

The potential impacts of the proposed road development on the hydrogeological receptors including groundwater resources, groundwater supplies, groundwater dependant terrestrial ecosystems and groundwater contributions to surface water have been assessed.

Groundwater Resources and Supplies

Where road cuttings are proposed then part of the aquifer will be removed, however, this amounts to a very small part of the aquifers and will have no perceptible impact on groundwater quantity. The water quality of the aquifers will not deteriorate due to the proposed road development and as such the proposed road development meets the requirements of the European Water Framework directive. The assessment highlights that five wells will be removed by the proposed road development. These wells will be decommissioned based on IGI guidelines.

All wells within 150m of the proposed development boundary (or within 150m of the drawdown zone of influence, whichever is the greater) will be monitored for 12 months before construction, during the duration of construction and for 12 months following completion.

Groundwater Dependant Terrestrial Ecosystems

Potential impacts from the proposed road development have been assessed for the hydrogeological setting of ecological habitats within the study area. The assessment has identified that karst is present in the Visean Undifferentiated Limestone and accordingly a karst protocol has been developed between geotechnical and hydrogeological specialists to mitigate against karst and to remove the risk of impact from the proposed road development encountering karst. There are no significant negative residual hydrogeological impacts to European sites due to the proposed road development.

Groundwater Contributions to Surface Water

Groundwater contributions to surface water have been assessed as part of this study, which has included identification of the surface water that groundwater bodies contribute to. The study has identified that there will be no significant negative impact in the groundwater contribution to surface water.

10.9 References

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11 Hydrology

11.1 Introduction

This chapter of the EIAR consists of an appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, under the heading of hydrology.

This chapter initially sets out the methodology followed (**Section 11.2**), describes the receiving environment (**Section 11.3**) and summarises the main characteristics of the proposed road development which are of relevance to hydrology (**Section 11.4**). The evaluation of impacts of the proposed road development on hydrology are described. (**Section 11.5**). Measures are proposed to mitigate these impacts (**Section 11.6**) and residual impacts are described (**Section 11.7**). The chapter concludes with a summary (**Section 11.8**) and reference section (**Section 11.9**).

This chapter has utilised the information gathered during the constraints and route selection studies for the proposed road development to inform the hydrology impact appraisal. **Sections 4.6, 6.5.4** and **7.6.4 of the Route Selection Report** considered the hydrology constraints within the scheme study area and compared the potential of hydrology impacts of the proposed route options respectively. These assessments and sections of the Route Selection Report contributed to the design of the proposed road development which this chapter appraises.

11.2 Methodology

11.2.1 Introduction

The following section outlines the legislation and guidelines considered and the adopted methodology for the preparing of this chapter.

11.2.2 Guidelines

This chapter has been prepared having due regard to the following guidance documents:

- Environmental Protection Agency (EPA) Guidelines on the Information to be contained in Environmental Impact Statements, March 2002
- EPA Advice Notes on Current Practice in the preparation of Environmental Impact Statements, September 2003
- Draft EPA Guidelines on the Information to be contained in Environmental Impact Statements, September 2015
- Draft EPA Advice Notes on Current Practice in the preparation of Environmental Impact Statements, October 2015
- Draft EPA Guidelines on the Information to be Contained in Environmental Impact Assessment Reports, August 2017

- Surface Water and Drainage Guidance in the National Roads Authority Design Manual for Roads and Bridges
- National Road Authority (NRA) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (referred to as TII Guidelines in this chapter)
- NRA Environmental Impact Assessment of National Roads Schemes – A Practical Guide, November 2008
- DoEHLG (Nov 2009) Flood Risk Management and the Planning System Guidance document
- Inland Fisheries Ireland (IFI) (2016) Guidelines on protection of fisheries during construction works in and adjacent to waters

The methodology follows the guidance outlined in Section 5.6 of the NRA Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes pertaining to the treatment of Hydrology. The impact category, duration and nature of impact have been considered in this assessment. The range criteria for assessing the importance of hydrological features within the study area and the criteria for quantifying the magnitude of impacts are assessed in accordance with the guidelines.

11.2.3 Data Sources and Consultations

The following list of data sources were reviewed as part of this assessment of the impacts on hydrology:

Ordnance Survey Ireland (OSi)

- Discovery Series Mapping (1:50,000) 2017
- Six Inch Raster Maps (1:10,560)
- Six Inch and 25inch OS Vector Mapping
- Orthographic Aerial Mapping 2012 and 2016

Environmental Protection Agency (EPA)

- Teagasc Subsoil Classification Mapping
- Water Quality Monitoring Database and Reports
- Water Framework Directive Classification 2015
- EPA Hydrometric Data System 2017

Office of Public Works (OPW)

- Arterial Drainage scheme land benefitting Mapping for Ireland
- OPW and Drainage District Arterial Drainage Channels and Maintained Channels
- OPW hydrometric Data website 2017
- OPW Floodmaps.ie website 2017

- OPW FSU (Flood Studies Update) Web Portal Site for Flood Flow Estimation
- OPW Preliminary Flood Risk Assessment Mapping (pFRA) 2011
- OPW Draft CFRAM Flood Risk Mapping, draft hydrology, hydraulics and flood risk management reports 2016

Galway County/City Council

- Galway County Development Plan (2015 – 2021)
- Galway City Development Plan (2017 – 2023)
- Galway Transport Strategy (2016)
- Planning Register
- Water Services Section

National Parks and Wildlife Service (NPWS)

- Designated Areas Mapping
- Site Synopsis Reports
- Conservation Objectives Documents

Other sources

- Western River Basin Management Plan (2009 – 2015)
- Aerial survey photography and Lidar
- Geological Survey of Ireland (GSI) Web Mapping
- Specially commissioned bathymetric surveys
- Topographical survey

Consultation took place with all relevant regulatory bodies including various departments of Galway County Council, Galway City Council, the OPW, GSI, National Parks and Wildlife Service (NPWS) and IFI.

11.2.4 Study Area and Baseline Data Collection

The extents of the study area are defined for the hydrology assessment as the lands within a 250m buffer of the proposed development boundary and the associated upstream and downstream catchments as shown on **Figures 11.101** to **11.114**.

Field surveys and walkover assessments were carried out to assess the hydrological impacts of the proposed road development. Detailed stream surveys (including topographical surveys where required) were undertaken at areas where hydrological impacts were likely to occur without appropriate mitigation. Specifically, all culvert and bridge crossing locations, proposed road drainage outfall locations and ecologically sensitive areas were visited and field measurements carried out along with reconnaissance of potential flood risk areas, including site visits during the December 2015/January 2016 winter flood event. The long duration rainfall and flooding in the River Corrib were notable and estimated flood flows in the River

Corrib were the worst since completion of the Salmon Weir Barrage in 1959 and the recorded flood magnitude at the Dangan Gauge represents c. 30 to 50year return period event.

Surface water quality monitoring was carried out of all main watercourses associated with the potential outfall receptors. Flow estimation in selected outfall streams was also conducted as were targeted bathymetric surveys of Coolagh Lakes, Ballindooley Lough and the River Corrib mainline channel.

11.2.5 Impact Assessment Methodology

The Hydrological Impact Assessment Methodology follows the guidance outlined in Section 5.6 of the TII Guidelines pertaining to the treatment of Hydrology. The Impact category, duration and nature of impact have been considered in this assessment. The range criteria for assessing the importance of hydrological features within the study area and the criteria for quantifying the magnitude of impacts are assessed in accordance with the TII Guidelines.

The hydrological assessment has been prepared by expanding and updating the desk study work carried out for constraints and route selection studies. It includes an assessment of published literature available from various sources including a web based search for relevant material. Site specific topographical information and aerial photography has been reviewed to locate any potential features of hydrological interest. These features have been investigated on the ground by walkover surveys to assess the significance of any likely environmental impacts on them.

Available topographical and hydrometric information (field and desk based) has been used to perform hydrological impact assessments of all required culvert crossings of existing watercourses and proposed outfall locations to existing streams and stormwater sewers. All watercourses and water bodies which could be affected directly (i.e. crossed or realigned/diverted) or indirectly (i.e. generally lie within 250m of the proposed development boundary or would receive storm runoff from the proposed road development) were assessed through a series of initial walkover visits followed up by a more detailed survey and hydrological assessment. Due to the nature of the hydrological environment, it is necessary to consider the larger river catchment environments that the proposed road development traverses.

The assessment of hydrological impacts for the proposed road development has been based on the analysis and interpretation of the data acquired during constraints and route selection studies, as well as site specific investigations undertaken as part of the EIA studies, including the ecological study, hydrogeological surveys, ground investigations, agricultural survey, topographical survey and hydrological walkover and surveys.

The key hydrological attributes identified along the proposed road development include:

- European designated sites including: Lough Corrib candidate Special Area of Conservation (cSAC), Galway Bay Complex cSAC, Inner Galway Bay SPA, and Lough Corrib SPA

- Annex I water dependant habitats
- Surface drinking water supply abstraction source from River Corrib at Jordan's Island
- Ecologically sensitive surface water features and catchment systems, fishery streams either locally or downstream, Fens, flushes and wetlands etc.
- Flood Risk Areas

These assessments included the potential hydrological impacts on European sites of the Galway Bay Complex cSAC), Inner Galway Bay SPA, Lough Corrib cSAC and Lough Corrib SPA and also of Ballindooley Lough which provides supporting habitat for birds within the Inner Galway Bay and Lough Corrib SPAs. Other neighbouring European sites such as Connemara Bog Complex cSAC, East Burren Complex cSAC, and Lough Fingall Complex cSAC are not hydrologically linked to the study area of the proposed road development. Other European sites such as, Black-Head-Pouallagh Complex cSAC and Inishmore cSAC, Inishmaan cSAC and Inis Oirr Islands cSAC which share the West of Ireland coastal waters are considered sufficiently remote that even a worst-case pollution event would have no perceptible impact given the travel time involved and the extensive dilution available.

The individual importance of these attributes has been then assessed with respect to their quality, extent / scale and rarity as set out in **Table 11.1** below.

Table 11.1: Criteria for Rating Site Attributes

Importance	Criteria
Extremely High	Attribute has a high quality or value on an international scale
Very High	Attribute has a high quality or value on a regional or national scale
High	Attribute has a high quality or value on a local scale
Medium	Attribute has a medium quality or value on a local scale
Low	Attribute has a low quality or value on a local scale

Types of hydrological impact fall into two broad categories of quantitative and qualitative impacts.

11.2.5.1 Quantitative Impacts

Hydraulic structures such as bridges, culverts, channel diversions and outfalls can, if not appropriately designed, impact negatively on upstream water levels and downstream flows. If a bridge or culvert opening is too narrow or a diversion channel undersized it may impede flow during times of floods thus causing water levels upstream of the structure to be raised above what would occur in the absence of the structure. If instream culvert structures and associated channel diversions and transitions are too wide or steep this can significantly affect the mean and low flow regime of the stream in terms of velocity and water depth changes resulting in low velocities and low water depths which can alter the local sedimentology and flow regime resulting in benthic impacts and potential fishery impacts.

In the design of the proposed road development, the adequacy of culvert sizes for local drainage areas and small river catchments is based on providing conveyance for the 100year return period flood event with recommended climate change allowance in accordance with OPW requirements. Blockage potential and maintenance requirements are also considered and are often the overriding design factor for small stream crossings. In this respect, the design flow used is based on gauged flow data, where available, and/or the upstream catchment characteristics of the crossing including:

- Catchment area
- Annual average rainfall for the catchment
- Mean channel slope (S1085)
- Soil type
- Flood Studies Report (FSR) 100-year flood growth factor of 1.96
- FSU catchment descriptors to estimate the annual index flood (Qmed)
- FSU pooling group flood growth factors

Each method included the standard factorial error for the related estimation method (Institute of Hydrology Report No. 124 3-variable equation (IH-124) = 1.65, Flood Studies Update (FSU) catchment descriptor flood estimation equation = 1.38). A climate change allowance of 20% increase on flows was also included in all flood flow estimations as is currently considered best practice.

Surface water drainage from the proposed carriageway, grassed margins/verges and embankment slopes can lead to localised increased flows and flooding in the receiving streams if not dealt with appropriately. The proposed drainage system is a combination of piped drains and carrier pipes, concrete surface water channels, slot drains, grassed surface water channels, and filter drains where permitted, which convey storm runoff to one of the various surface outfall locations located along the length of proposed road development.

11.2.5.2 Qualitative Impacts

Depending on the hydrological and ecological sensitivities of the receiving waters of the proposed drainage outfall, treatment of the storm water via online or offline detention / water quality improvement ponds are required upstream of the outfall to protect the water quality particularly from spillage and first flush events. The potential contaminant load and accidental spillage risk for a single outfall and sub-catchment area is a function of the design traffic and road pavement area and length.

11.3 Receiving Environment

11.3.1 Regional Overview of Hydrology

The proposed road development connects to the R336 Coast Road west of Bearna Village, passes to the north of Galway City and joins the existing N6 at Coolagh, Briarhill. It crosses the River Corrib near Menlo Castle on the eastern bank and on the western side it passes through National University of Ireland Galway (NUIG) Sporting Campus at Dangan. The River Corrib channel at the crossing site is within the Lough Corrib candidate Special Area of Conservation (cSAC) (000297) as are the Coolagh Lakes further to the southeast. The Lough Corrib SPA boundary includes Lough Corrib and extends down the River Corrib channel to north of Dangan. One proposed road drainage outfall from the proposed N59 Link Road North discharges into the Lough Corrib SPA and Lough Corrib cSAC designated waters. All remaining outfalls for the proposed road development are located downstream of the Lough Corrib SPA, with two proposed road drainage outfalls discharging directly into the Lough Corrib cSAC and the drainage from the proposed NUIG pitches also indirectly discharging to the Lough Corrib cSAC. The proposed road development lies within the OPW/EPA's hydrometric areas 29, 30 and 31.

The proposed road development intercepts several watercourses principally to the west of the River Corrib which will require culverting to maintain existing hydraulic connectivity. To the east of the River Corrib due to the highly karstic nature of the terrain there is a very sparse network of surface water drainage channels, ditches and stream channels. Rainwater generally infiltrates to ground through the limestone till and weathered karstified limestone bedrock, rather than directly running off as overland flow. Consequently, only one dry ditch was noted as being intercepted by the proposed road development near the Coolagh Lakes to the east of the River Corrib. Whereas, to the west of the River Corrib, the bedrock and quaternary changes to a more impervious type due to the underlying granite bedrock (east of N59 Moycullen Road) resulting in a much higher density of surface water drainage features with little ability for rainwater to infiltrate to groundwater. This gives rise to wetter conditions with peatlands and marshy areas quite common along the route of the proposed road development.

All of the rivers, streams, drains, lake features and groundwater bodies along the route of proposed road development eventually outfall into Galway Bay via the River Corrib Estuary or directly and indirectly to coastal and transitional waters via the coastal watercourses or via groundwater flow through both diffuse and preferential karst conduit flow pathways. The transitional waters (estuarine waters whose salinity is diluted by the River Corrib outflow and other smaller streams) are located between Salthill to the west and Roscam headland to the east and extend southwards to approximately 0.5 to 1km south of Mutton Island. The designated coastal waters of Galway Bay extend from Blackrock in Salthill east to Roscam Headland and Roscam Point. East of Roscam Point, the Oranmore Bay Transitional Waters are located.

The study area falls within the Western River Basin District (WRBD). The WRBD has classified the transitional coastal waters as good status, the coastal waters as moderate status and Lough Corrib as moderate lake quality (previously classified as poor). The majority of the watercourses and lakes within the study area do not have their status assigned (this includes Coolagh Lakes and Ballindooley Lough and all of the western watercourses). The only watercourses that have been classified are the Terryland River which has a water quality status of poor, the River Corrib which has a status of good and the lower reach of the Bearna Stream which was previously given a pass classification and is currently unassigned. However, all waterbodies within the study area, designated or otherwise, are treated as sensitive. The design approach to waterbodies is to maintain or improve the hydrological regime. This aligns with the objectives of the Water Framework Directive and the Western River Basin Management Plan to achieve Good status for all of its surface watercourses.

The groundwater bodies (GWBs) encountered by the proposed road development are the poorly productive bedrock GWB in the granite bedrock formations to the west of the N59 Moycullen Road and regionally important karst conduit flow limestone bedrock GWB to the east of the N59 Moycullen Road. The groundwater quality classification is good for the entire study area and wider catchment, but the karst GWB's are identified as at risk of not achieving good status whereas the poorly productive bedrock GWB to the west of the N59 Moycullen (Spiddal and Maam-Clonbur GWBs) are expected to achieve good status. For further details, refer to **Chapter 11, Hydrogeology**.

11.3.2 Climatological Data

The mean long term annual rainfall (SAAR) for the proposed road development varies slightly with a tendency for increased rainfall from east to west. The SAAR value for the Bearna area is typically 1275mm, whereas at the River Corrib crossing point, it is 1250mm and in the Ardaun / Doughiska area it is 1140mm.

The Annual Potential Evapotranspiration Rate based on the Athenry Meteorological Station is 508mm and for the Mace Head Station it is 562mm. The Athenry Station is considerably more suitably located to the proposed road development than the Mace Station and therefore considered more applicable. Combining this with the annual rainfall, the typical effective rainfall rate for recharge and runoff is calculated as 714mm.

The Met Éireann Rainstorm Depth-Duration-Frequency Model for the Galway City area is presented below in **Table 11.2** for durations of 0.25hrs to 25days and return periods of 2 to 200years (Annual Exceedance Probability (AEP) 50% to 0.5%).

Table 11.2: Rainstorm Depth-Duration-Frequency Relationship for the Galway City Area

Return Period	Duration (hrs)																			
	0.25	0.5	1	2	3	4	6	9	12	18	24	48	72	96	144	192	240	288	384	480	600
2yr	7.9	10.6	14.3	19.3	23	26	31	36.9	42	50	55.9	69.8	81.6	92.3	111.6	129	146	162	191	220	254
5yr	10.4	13.8	18.3	24.3	28.7	32	38.1	45	51	60	66.8	82.6	96	108.2	130	150	169	186	220	252	290
10yr	12.2	16.1	21.1	27.8	32.7	37	43	50.6	57	67	74.1	91.1	106	118.6	142.1	163	183	202	238	272	313
20yr	14.1	18.5	24.1	31.5	36.9	41	48.1	56.3	63	74	81.6	99.8	115	129.2	154.3	177	198	219	257	293	336
30yr	15.4	20	26	33.8	39.4	44	51.3	59.8	67	78	86.1	105	121	135.6	161.6	185	207	228	268	305	350
50yr	17	22	28.5	36.9	42.9	48	55.5	64.5	72	84	92.1	112	129	144.	171.2	196	219	241	282	321	368
100yr	19.6	25.1	32.3	41.5	48	53	61.7	71.4	79	92	100.9	122	140	156.	184.9	211	236	259	303	344	393
150yr	21.2	27.1	34.7	44.4	51.3	57	65.6	75.7	84	97	106.3	128	147	163.4	193.4	221	246	270	315	358	408
200yr	22.5	28.6	36.5	46.6	53.7	59	68.5	78.9	87	101	110.3	133	152	168.9	199.7	228	254	278	324	368	420

Table 11.3: Monthly Climatological Data Recorded at Mellows College, Athenry Station (2013 to 2016)

a) Total rainfall in millimetres for Athenry Station (Mellows College)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2018	173.2	78	81.4	82.2	32.3								
2017	47.4	87.5	142.6	13.5	61.4	119.5	136.8	103.1	118.3	123.3	88.9	157.7	1200.0
2016	145.2	129.8	79.4	49.2	56.7	98.5	85.1	96.3	138.0	58.4	59.1	78.5	1074.2
2015	191.1	68.7	129.9	74.8	138.0	44.9	138.2	114.6	93.3	66.6	216.3	299.4	1575.8
2014	182.5	177.7	103.1	47.6	103.1	38.6	92.4	104.9	10.4	140.9	139.0	124.1	1264.3
2013	132.2	46.5	36.9	102.4	97.2	61.4	101.5	72.8	47.9	120.0	100.0	220.3	1139.1
Mean	**116.7**	**87.8**	**94.7**	**72.0**	**75.3**	**79.6**	**86.5**	**107.8**	**100.3**	**128.9**	**120.3**	**123.2**	**1192.9**

b) Mean temperature in degrees Celsius for Athenry (Mellows College)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2018	5.3	3.6	4.5	8.6	10								5.9
2017	6.2	6.1	8	8.9	12.2	13.8	14.4	13.8	12.2	11.1	6.8	5.6	10
2016	5.7	4.7	6.3	7.2	11.8	14.9	14.8	15.3	13.7	10.3	5.5	6.8	9.8
2015	4.9	4.5	6.0	8.3	9.8	12.4	13.5	13.5	12.3	10.0	9.0	8.1	9.4
2014	5.3	5.5	6.9	10.1	11.5	14.4	16.1	13.8	13.9	10.5	6.9	5.6	10.1
2013	5.2	4.7	3.8	7.2	10.2	13.3	17.5	15.0	13.6	11.7	6.4	6.9	9.7
Mean	**5.5**	**5.6**	**7.1**	**8.6**	**11.3**	**13.7**	**15.5**	**15.2**	**13.2**	**10.2**	**7.5**	**5.6**	**9.9**

c) Potential Evapotranspiration (mm) for Athenry (Mellows College)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2018	11.1	17	30.9	51.5	25.4								
2017	11.7	17.6	36.6	49.2	84.8	76.9	76.1	61.1	42.1	23.5	10.4	8.7	498.7
2016	13.1	17.3	34.5	53.4	80.3	84.2	72.2	61.2	39.9	26.5	9.8	3.4	495.8
2015	13.2	14.6	33.8	60.7	65.2	78.9	71.3	63.4	43.6	23.9	17.6	16.0	502.2
2014	10.8	19.3	32.6	58.5	65.7	87.4	81.8	66.5	47.9	26.3	9.9	10.6	517.3
2013	6.5	14.6	28.7	52.9	68.4	82.4	98.6	65.0	44.1	27.0	12.4	14.8	515.4
Mean	**11.1**	**16.7**	**32.9**	**54.4**	**65.0**	**82.0**	**80.0**	**63.4**	**43.5**	**25.4**	**12.0**	**10.7**	**497.1**

11.3.3 Hydrological Drainage Features

There are five principal hydrological drainage catchments and their sub-catchments intercepted/potentially impacted by the proposed road development which are labelled from west to east as follows (refer to **Figures 11.1.101** and **11.1.114**):

1. Sruthán Na Libeirtí Stream
2. Trusky Stream
3. Bearna Stream
4. Knocknacarra Stream
5. Corrib Catchment
    a. River Corrib
    b. Coolagh Lakes
    c. Terryland River
    d. Ballindooley Lough System

There are six downstream sub-catchments that also discharge to the Galway Bay Complex cSAC and Inner Galway Bay SPA, namely Lough Atalia, Doughiska, Curragreen, Galway City Coastal, Roscam and Glenascaul drainage areas. These small drainage catchments are located on the eastern side of the River Corrib within the karst limestone bedrock formation and do not have surface drainage features. Effective rainfall from these catchments drains to groundwater or is intercepted by the existing urban storm drainage systems.

Two very minor coastal streams / drains exist at An Baile Nua, Bearna which drain directly into the sea at Bearna.

11.3.4 Hydrological Catchments

11.3.4.1 Sruthán na Libeirtí

Sruthán na Libeirtí is a small stream which rises in a peatland land area 2km north of the R336 Coast Road and flows southwards to the coast outfalling to Galway Bay 2km west of Bearna Village at Cora na Libeirtí at An Baile Nua. This stream is unmaintained, narrow (typically 0.5m to 1m wide) and shallow < 0.5m.

Sruthán na Libeirtí has a catchment area of 1.5 km^2 and high percentage runoff due to its generally impermeable overburden cover and shallow bedrock. There are no sources of gauged flood flow information for this stream given its very minor scale, but this watercourse has been included in the Flood Studies Update (FSU) for flood flow estimation of the index Flood flow magnitude (mean and median flow magnitude) based on catchment descriptors for a number of prediction points along the stream reach.

Table 11.4: FSR Catchment Characteristics for the Sruthán na Libeirtí

Catchment Characteristic	
AREA (km^2)	1.47
Annual Rainfall SAAR (mm)	1300
Winter Rainfall Acceptance potential SOIL Index	0.3 (type 2)
Channel Flood Slope S1085 (m/km)	25.0
URBAN – fraction of catchment	0%

Table 11.5: FSU Catchment Descriptors for the Sruthán na Libeirtí (Source OPW FSU Web Portal Site)

Catchment Characteristic	
AREA (km^2)	1.47
Annual Rainfall SAAR (mm)	1281
FARL	1.0
BFISOIL Baseflow Index of Soils	0.4512
Drainage Density DRAIND km per km^2	2.999
Channel Flood Slope S1085 (m/km)	25.08
Arterial Drainage Factor ARTDRAIN2	0.0
URBAN – fraction of catchment	0.0098

QMED rate =1.135cumec (0.77cumec per km2 representing a moderately high runoff rate)

Note FSR is the Flood Studies Report completed in 1975 and supplementary studies carried out in the late 1970's, 1980's and 1990's for estimating flood flow magnitudes ingauged and ungauged catchments and the FSU represents the OPW Flood Study Update method completed in 2105 succeeds the FSR method.

11.3.4.2 Trusky Stream

The Trusky Stream which flows through Bearna is a relatively small stream having a catchment area of $3.3km^2$ and outfalls to Galway Bay at Bearna Harbour. This stream has two main branches, one to the east of the harbour road and one to the west. The stream channel has been culverted and modified through Bearna Village and crosses under the R336 Coast Road in two culverts; an original arch culvert near the Twelve Pins Hotel and a concrete piped culvert, located approximately 170m to the east. This stream potentially represents a flood risk to the village and R336 Coast Road at these culvert crossings as a result of potential debris blockage. This stream rises in peatland to the south of Lough Inch and flows typically southwards 2.5km to the harbour. The channel is not maintained, very vegetated and varying in width (0.5 to 1m channel widths) in its middle and upper reaches. The channel through the lower reach has been significantly modified with sections of culverting and new channel to facilitate urban development. Unlike the Sruthán na Libeirtí, the percentage runoff is moderate to low.

Table 11.6: FSR Catchment Characteristics of the Trusky Stream

Catchment Characteristic	
AREA (km^2)	3.3
Annual Rainfall SAAR (mm)	1300
Winter Rainfall Acceptance potential SOIL Index	0.3 (Type 2)
Channel Flood Slope S1085 (m/km)	21.9
URBAN – fraction of catchment	0%

Table 11.7: FSU Catchment Descriptors of the Trusky Stream (Source OPW FSU Web Portal Site)

Catchment Characteristic	
AREA (km^2) (corrected error in FSU)	3.3
Annual Rainfall SAAR (mm)	1293
FARL	1.0
BFISOIL Baseflow Index of Soils	0.6877
Drainage Density DRAIND km per km^2	1.128
Channel Flood Slope S1085 (m/km)	18.4
Arterial Drainage Factor ARTDRAIN2	0
URBAN – fraction of catchment	0.0622

The median flood flow (Qmed) estimate for this stream from the FSU is 1.26cumec (representing a runoff rate of 0.38cumec per km^2 which is a moderate to low flood runoff rate).

11.3.4.3 Bearna Stream

The Bearna Stream is the largest of the small watercourses encountered by the proposed road development entering Galway Bay cSAC and Inner Galway Bay SPA near Rusheen Bay. Its catchment area measures only 9.1km^2 to its sea outfall in Rusheen Bay and its main tributaries are the An Sruthán Dubh and the Tonabrocky Streams. This river system rises in the townlands of Pollnaclogha, Drum and Tonabrocky 4km to the north. It is an unmaintained stream which in sections is very overgrown particularly in its middle and upper reaches. Flooding is not a significant issue for this stream. The percentage runoff based on overburden and land slope is moderate to low in magnitude.

Table 11.8: FSR Catchment Characteristics of the Bearna Stream

Catchment Characteristic	
AREA (km^2)	9.1
Annual Rainfall SAAR (mm)	1290
Winter Rainfall Acceptance potential SOIL Index	0.3 (Type 2)
Channel Flood Slope S1085 (m/km)	13.5
URBAN – fraction of catchment	0.5%

Table 11.9: FSU Catchment Descriptors of the Bearna Stream (Source OPW FSU Web Portal Site)

Catchment Characteristic	
AREA (km^2)	9.14
Annual Rainfall SAAR (mm)	1292
FARL	0.979
BFISOIL Baseflow Index of Soils	0.601
Drainage Density DRAIND km per km^2	1.422
Channel Flood Slope S1085 (m/km)	0.1
Arterial Drainage Factor ARTDRAIN2	0.0
URBAN – fraction of catchment	0.05

The estimated QMED median Flood flow is 3.41cumec representing a moderate to low runoff rate of 0.37cumec per km^2.

11.3.4.4 Knocknacarra Stream

The Knocknacarra Stream is a small and highly urbanised stream that discharges to Galway Bay Complex cSAC and Inner Galway Bay SPA near Blakes Hill in Salthill. A large portion of its lower reach is culverted almost to its sea outfall and forms part of the Galway City storm drainage system. It rises to the north of Rahoon at Letteragh and flows southwards over a distance of 3km to the sea. It would be considered a highly urbanised watercourse with an urban fraction of almost 50%.

Table 11.10: FSR Catchment Characteristics of the Knocknacarra Stream

Catchment Characteristic	
AREA (km2)	4.4
Annual Rainfall SAAR (mm)	1240
Winter Rainfall Acceptance potential SOIL Index	0.3 (Type 2)
Channel Flood Slope S1085 (m/km)	10.0
URBAN – fraction of catchment	49%

Table 11.11: FSU Catchment Descriptors of the Knocknacarra Stream River (Source OPW FSU Web Portal Site)

Catchment Characteristic	
AREA (km^2)	4.38
Annual Rainfall SAAR (mm)	1239.6
FARL	1.0
BFISOIL Baseflow Index of Soils	0.61
Drainage Density DRAIND km per km^2	0.757
Channel Flood Slope S1085 (m/km)	10.01
Arterial Drainage Factor ARTDRAIN2	0.0

Catchment Characteristic	
URBAN – fraction of catchment	0.5

The estimated QMED median Flood flow is 2.82cumec representing a moderate runoff rate of 0.644cumec per km^2. This runoff rate almost doubled over the rural greenfield runoff due to significant size of the urbanised catchment fraction.

11.3.4.5 Terryland River

The Terryland River also known as the Sandy River is a small drainage system that essentially drains the Terryland Basin with a total catchment area of 6.75km^2. The stream's outlet is to groundwater via two swallow-holes located at Poulavourleen, west of Castlegar Village. Old historic maps of Galway (Grand Jury Map 1819) show that this stream was a spur off the River Corrib channel and the valley floor was almost a lake bed during winter flooding. Arterial drainage works as part of a Public Works Corrib Drainage and Navigation Scheme were carried out in the 1850's and as part of these works constructed the Dyke Road embankment to prevent flooding from the River Corrib and allow the reclamation of the Terryland Valley for farmland. Today, this embankment and the Salmon weirs gated controls protect important commercial, industrial and retail developments that include the Galway Retail Park, Galway Shopping Centre, Terryland Shopping Centre, Terryland Retail Park and Liosbán Industrial Estate.

A water intake from the River Corrib, near Jordan's Island, provides controlled inflow from the River Corrib to feed the city water supply at the Terryland Galway City Water Treatment Works with the excess discharging to the Terryland River. This inflow from the River Corrib to the Terryland River in terms of stream flow is relatively small and not significant in respect to flood flow contribution. The watercourse is partially tidal with the tidal signal (0.7 to 0.8m range on spring tides and 0.3 to 0.4m range on neap tides upstream of the swallow-holes) evident and particularly so on spring tides which produces an almost reversal in flow direction coinciding with the flooding and ebbing spring tides (Terryland River Valley Drainage Scheme Report, 1998). These swallow holes are believed to discharge to Galway Bay but the location of the outlet in Galway Bay is unknown. The integrity of these swallow holes is unknown. Ballindooley Lough is considered to be part of the Terryland catchment but this connection has not been proven. The connection may be possible through the groundwater flow as Ballindooley Lough is at the base of an enclosed depression.

The inflow from the River Corrib is via a manmade channel referred to as the Galway Bore which is also the abstraction / intake channel to the Terryland Water Treatment Plant. The excess flow overspills with a fall of 3m to the Terryland River Basin. Historical maps (1819) show the entire Terryland River Valley as inundated and part of the River Corrib system. The capacity of the swallow-holes is unknown and a previous 1998 KT Cullen Study for Galway City Council recommended that development levels are set above 7m OD which is equivalent to the River Corrib level in severe flood (> 100year Return Period in River Corrib upstream of Salmon Weir Barrage). The CFRAM model study makes certain assumptions with predicted levels significantly lower at 3.4 and 4.94m OD for the 100 and 1000-year events for the Terryland River Valley.

Table 11.12: FSR Catchment Characteristics of the Terryland River

Catchment Characteristic	
AREA (km^2)	6.75
Annual Rainfall SAAR (mm)	1160
Winter Rainfall Acceptance potential SOIL Index	0.15 (type 1)
Channel Flood Slope S1085 (m/km)	0.4
URBAN – fraction of catchment	0.44

Table 11.13: FSU Catchment Descriptors of the Terryland River (Source OPW FSU Web Portal Site)

Catchment Characteristic	
AREA (km^2)	6.75
Annual Rainfall SAAR (mm)	1163
FARL	1
BFISOIL Baseflow Index of Soils	0.5726
Drainage Density DRAIND km per km^2	0.529
Channel Flood Slope S1085 (m/km)	0.435
Arterial Drainage Factor ARTDRAIN2	1.0
URBAN – fraction of catchment	0.435

The estimated QMED median flood flow is 1.92cumec representing a moderate flood runoff rate of 0.284cumec per km^2. This runoff rate almost doubled that of a greenfield rural catchment due to significance of the urbanised fraction at 43.5%. The capacity of the swallow-holes is unknown, but to date have been sufficiently ample as not to result in any significant inundation of the basin area.

11.3.4.6 River Corrib

The River Corrib is essentially a short outflow channel from the Lough Corrib to the sea at the Claddagh, Galway. The Corrib Navigation and Drainage Works (1848-1858) excavated a new wide outlet channel from Lough Corrib known as the Friar’s Cut which provides a more direct and deeper channel to service the lough than the meandering old channel (almost 1.5km shorter). Significant excavation of the River Corrib channel has taken place both during the original Corrib Drainage and Navigation Scheme and during the OPW Corrib-Clare Arterial Drainage Scheme (in the early 1960’s).

The area of the River Corrib catchment is approximately 3,136 km^2 to Wolfe Tone Bridge and 3121km^2 to Dangan Gauge based on DTM elevation data. This catchment area is quite large by Irish standards and is the biggest river system in the Western River Basin District. This includes a total lake surface area of approximately 314km^2 mainly due to Lough Corrib and Lough Mask but also includes Lough Carra, Finny Lakes and Maam Lakes which attenuate winter flood flows and sustain summer low flows. The register of hydrometric gauges has the catchment area to Wolfe Tone Bridge of 3111km^2 which is slightly less than the FSU estimate.

The River Corrib channel is a navigation channel and is reasonably wide, varying typically from 80m to 130m between river banks and typically 3 to 4 m deep. It is an impounded channel with levels maintained generally close to 6m OD Malin throughout the year by the gated weir at the Salmon Weir.

Table 11.14: Exceedance Percentile at Dangan Gauge

Exceedance Percentile at Dangan Gauge				
1%	5%	50%	95%	99%
6.75mOD	6.32mOD	5.91mOD	5.75mOD	5.70mOD

Much of the channel has been excavated with bed levels at the proposed road development crossing point at 2.75m OD, providing a flow area at summer 99-percentile low flow of 300m^2 and a channel velocity of 0.04m/s.

The River Corrib for flow estimation is gauged at Wolfe Tone Bridge which is a strategic location as it captures the total flow from the Corrib system before entering the bay. This site is tidally backwatered and the flow rating is considered only fair. Flow estimates from this gauge are currently not available due to difficulties and inconsistencies with the rating relationship identified in the gauged record dating back as far back as 2002. As part of the flood risk assessment for the proposed road development a reasonably consistent flood rating relationship was derived for the Dangan Gauge using the OPW flood rating measurements and recorded flood level flooding stage when all gates on the Salmon Weir are opened, which generally applies to winter maximum floods. This rating provided a QMED (2year return period) flow at Dangan of 264.4cumec (gauged period 1986 to 2015). The OPW CFRAM study produced a QMED estimate of 248cumec and the FSU estimate is 244cumec (both based on the Wolfe Tone Bridge gauge data for the record period pre 2002).

The statistical analysis of a derived annual maximum flood flow series for the Dangan of 264.4cumec is considered more reliable than the FSU and CFRAM estimates as it includes the more recent and wetter period post 2002 and avoids using the Wolfe Tone gauge whose rating is inconsistent. The flow duration curve for Wolfe Tone Bridge gauge (OPW hydrometric section) for the period 1970 to 1997 gave a median (50%) flow of 82cumec, a 95% low flow of 24.6cumec and a 99% low flow of 9.1cumec. The EPA Hydrological data publication (1995) for the record period 1970 to 1991 gave an average flow of 95.3cumec and a 95% low flow of 16.9cumec.

A study undertaken by the Department of Hydrology University College Galway (UCG) (now known as NUIG), (1985) as part of their investigation into the hydropower potential of the waterways of Galway City, developed a flow duration curve for the River Corrib at Wolfe Tone Bridge gauge (using OPW flow data from 1950 to 1980), which gave a mean flow rate of 82.5cumec and the lowest recorded flow of 8.9cumec (occurring in 1962). This flow duration curve gave median flow of 74.4cumec, 95-percentile low flow of 14.1cumec and a 99-percentile low flow of 12.13cumec. It should be noted that the period 1950 to 1980 in terms of rainfall would have represented a drier period than 1980 to present day and therefore the flow estimates are lower, particularly for the 1970's and 1950's which were the driest decades. For the purpose of this study, the lower estimates of low flow using a 99-percentile of 12cumec and a 95-percentile of 14cumec will be used. These low flow estimates assume the worst case dilution volumes for the receiving water body in respect to proposed road drainage discharges.

Table 11.15: FSU Catchment Descriptors of the River Corrib to Dangan (Source OPW FSU Web Portal Site)

Catchment Characteristic	
AREA (km^2)	3121
Annual Rainfall SAAR (mm)	1423.6
FARL	0.661
BFISOIL Baseflow Index of Soils	0.781
Drainage Density DRAIND km per km^2	0.94
Channel Flood Slope S1085 (m/km)	0.568
Arterial Drainage Factor ARTDRAIN2	0.411
URBAN – fraction of catchment	0.004

The FSU estimated QMED flood flow for the Corrib at Wolfe Tone is 244cumec representing a relatively low flood runoff rate of approximately 0.078cumec per km^2. The recommended QMED estimate based on the Dangan Gauge is 264.4 giving a slightly higher flood runoff rate of 0.085cumec per km^2.

The typical winter-summer water level range is 0.6m (typically 5.7m to 6.3m OD). The River Corrib channel at Dangan is approximately 110m wide and the channel bed invert near the crossing is typically 2.6 to 2.8m OD giving a flow depth of 3m and a total flow area of $312m^2$ at 5.7m OD and $403m^2$ at 6.3m OD. At a low flow (95-percentile) of 14cumec the average channel flow velocity is small at 0.044m/s and in typical winter flows the average velocity is 0.675m/s.

11.3.4.7 Ballindooley Lough

Ballindooley Lough is an enclosed lough located on the N84 Headford Road at Ballindooley, on the outskirts of Galway City. The lough forms at the floor of a large enclosed depression having a surrounding topographical catchment area of $2.25km^2$. The recent December 2015/January 2016 flood event, during which water levels peaked on the 2 Jan 2016, produced possibly the highest flood levels in at least 50 years both within this system and within the River Corrib system, with the maximum flood level recorded at 10.29m OD Malin. The typical summer lake low water level is approximately 1.5m lower at c.8.8m O.D. and in more severe drought conditions it is likely that lake levels fall below 8.5m O.D. This suggests that the more extreme annual range in lake level is of the order of 2m but for a typical year it is likely to be between 1 and 1.5m.

During the recent December 2015/January 2016 flood event, maximum winter flood levels both in the River Corrib and Lough Corrib reached 6.93m OD and

7.27m OD respectively and water levels in the Terryland Basin near Castlegar were below 4m OD.

A bathymetric survey of the Ballindooley Lough as part of this study showed that the deepest part of lake has a bed level of -2.5m OD Malin (i.e. 2.5m below mean sea level) whereas the overbank floodplain area is typically at an elevation of 9.3 to 9.5m O.D. This bed level suggests that at its deepest location, the water depth is 12m.

At the maximum recorded flood level of 10.29m OD, the surface area of the lake expands to 29.7ha and at the summer low water level of 8.5m OD it reduces to c. 4.5ha (4.2ha main lake and 0.3ha small pond to the southwest, both connected via a 3m wide and 250m long drain). There is over 2.4km of drainage channel draining the floodplain area of this lough, which feeds into the permanent lake. This drainage channel is reasonably maintained and typically the cross-section dimensions are 1.5 to 2m deep and 3m top width. The live storage volume between the winter high of 10.3m OD Malin and the summer low level of 8.5 is 271,500m^3. Approximately 500mm of rainfall (recorded at Met Éireann gauge in Athenry) fell in November and December 2015 and resulted in Ballindooley Lough rising by 1.3m from c. 9m OD to 10.3m OD. This represents a change in lake storage volume of almost 250,000m^3, which is 22% of the recorded rainfall depth over the 2.25km^2 catchment area.

The recession characteristics of the recorded lake levels indicate that the water level empties slowly (falls) by typically 0.8 to 1cm per day with almost similar recession characteristics at both high and low lake levels. In the summer period this fall is likely to represent evaporation losses from the lake surface. This slow almost constant like fall in levels suggests an emptying process influenced by the slower more continuous regional groundwater flow with the lake rising and falling with the groundwater table as opposed to a concentrated point (conduit flow via a swallow hole) outflows. The hydrological monitoring indicates that the lake is perched above the surrounding groundwater table in summer dry periods and influenced by the groundwater table in the wetter winter period. The proposed road development in terms of the groundwater table and groundwater flow is located down gradient of Ballindooley Lough. This feature is explained further in **Chapter 10, Hydrogeology**.

11.3.4.8 Coolagh Lakes

The Coolagh Lakes are part of the River Corrib system and are located within the Lough Corrib cSAC. The lake level within Coolagh Lakes is significantly influenced by the River Corrib water levels and the control imposed by the OPW at the Galway City Salmon Weirs Barrage (regulation 5.82 to 6.43m O.D. which is achieved approximately 85% of the time). This is not always achievable particularly during extreme flood events with lake levels exceeding the regulation levels. The periodic closure and opening of gates by the OPW creates inflow and outflow to the lakes in particular to the outer lake which provides additional flushing to the natural local catchment inflows. The water level in the Coolagh Lakes increases until it has positive head to outflow to the River Corrib channel upstream of Jordan’s Island via its small narrow outflow channel.

A bathymetric survey of the River Corrib and Coolagh Lakes revealed very deep bed levels within the middle of the two lakes with the deepest part of the lakes at c. -10 and -12m OD Malin respectively. This represents a maximum water depth of 16.5 and 18.5m for the inner and outer lakes respectively. Flow velocities within these lakes are very small with mixing principally by thermal differences and surface wind dynamics. These lakes are likely to represent a permanent sink for sediment if it were to enter such a system. The estimated winter 1-percentile water level for Coolagh Lakes is 6.75m OD producing an inundation area of 36ha, whereas the 99% exceedance summer low flow level is 5.73m OD with a lake area of 6.8ha.

The local catchment area draining to these lakes based on the topography is approximately 2.5km^2. Other deeper groundwater connections to karst areas to the northeast and east cannot be ruled out. Spring flow is evident in the Coolagh Lakes at two spring locations to the east and to the north. The mean annual inflow rate to the lakes is estimated to be approximately 30l/s based on water balance calculations. The low flow (95%-percentile) contribution is potentially as low as 2 to 3l/s. The bathymetric survey data for the lake is used to estimate the lake storage-stage relationship which for a summer low water level of 5.7m OD is c.630,000m^3 with a combined lake surface area upper and lower lakes) of c. 6.8ha (i.e. the permanent lake volume). Further storage volume and surface area statistics are presented below in **Table 11.16**.

Table 11.16: Percentile Lake levels, surface areas and storage volumes in the Coolagh Lakes system

Percentiles	1%	5%	50%	95%	99%
Lake level	6.64mOD	6.24mOD	5.86mOD	5.73mOD	5.70mOD
Area	36.0ha	30.4ha	10.9ha	7.2ha	6.8ha
Volume	801,000m^3	694,500m^3	649,000m^3	639,000m^3	637,000m^3

The annual winter-summer difference in storage volume (represented by the difference between the 1 and 99-percentile water levels) is 164,000m^3, therefore the average flushing ratio of this lake system by the River Corrib summer-winter water level variation is approximately 4 years at 5l/s. The natural flushing effect of recharge from the local catchment area is significantly higher at 0.7 years (250 days) at a mean annual inflow of 30l/s and the combined effect of the local recharge and the River Corrib is of the order of 35l/s producing an average hydraulic retention period of 215 days. These hydraulic retention times suggest moderate flushing time / exchange rate for a lake system.

The fringes of Coolagh Lakes dry out and only get inundated in winter by the River Corrib water levels. Alkaline fen habitat has been identified surrounding the lakes which are fed by groundwater flow and seepages. The waters within the lakes are quite alkaline with the hardness values recorded in excess of 200 mg/l $CaCO3$ and the pH at 7.8 to 8.2.

11.3.5 Surface Water Ecological Status

The locations of the watercourses and their catchment areas encountered along the proposed road development are given in **Figures 11.1.101** to **11.1.114**.

Given the European designation and salmonid status of the River Corrib (part of the Lough Corrib cSAC and Lough Corrib SPA) it is considered to be of International Status with an extremely high attribute value. The River Corrib catchment size is 3136km^2 to Wolfe Tone Bridge. The remaining watercourses encountered within the study area are all minor watercourses, with all such streams having catchment areas of well less than 10km^2, the streams are listed below:

- Coastal Streams at Baile Nua (<0.75km^2)
- Sruthán Na Libeirtí (1.5km^2)
- Trusky Stream (3.3km^2)
- Bearna Stream (9.14km^2)
- Knocknacarra Stream (4.4km^2)
- Terryland Stream (6.7km^2)

These watercourses generally have ecological attribute value of locally higher value.

The Galway Bay Complex cSAC and Inner Galway Bay SPA are coastal/transitional waters with the European designated waters commencing east of White Strand beach.

The Sruthán Na Libeirtí and Trusky Stream and the two minor watercourses at An Baile Nua, Bearna, that outfall to the sea near Bearna do not directly discharge to the Galway Bay Complex cSAC. The remaining streams, that the proposed road development traverse, all outfall directly into the Galway Bay Complex cSAC. The tidal circulation of the coastal waters off Bearna will eventually mix and on the flooding tides potentially enter the Galway Bay Complex cSAC. Therefore, the proposed drainage of the proposed road development will eventually drain into the Galway Bay Complex cSAC.

The Terryland River which has a water intake from the River Corrib at Jordan's Island drains the Terryland basin and disappears underground via karst swallow-holes near Castlegar. The outflow from these swallow holes is unknown but is likely to discharge to the Galway Bay Complex cSAC via submarine springs. The water level in the Terryland River shows a tidal response indicating its outflow point/points are within the tidal zone.

The majority of the above streams have either partially or extensively urbanised catchments. The fishery resource of these streams is assessed in detail in **Chapter 8, Biodiversity** and is summarised below:

- The two minor coastal streams at Baile Nua are not of fishery interest
- Sruthán na Libeirtí is categorised as of local importance (lower value) for European eel and with no salmonids present. The lower reaches have some moderate quality salmonid and European eel habitat

- The Trusky Stream is categorised to be of local importance (higher value) for salmonids, European eel and as a nursery for flounder in its lower reaches at Bearna. Some spawning habitat for trout exists in the lower reaches but this is limited
- The Bearna Stream is salmonid and is categorised to be of local importance (higher value) for Brown trout. Upper reaches are seasonal but moving downstream the habitat becomes an important salmonid river
- An Sruthán Dubh is a tributary of the Bearna Stream and is considered to be an excellent salmonid habitat throughout its upper reaches and is considered an excellent nursery salmonid stream with good numbers of juvenile Brown trout and small numbers of European eel. This is classified to be of local importance higher value for Brown trout and European eel
- The Knocknacarra Stream is categorised to be of local importance (higher value) for European eel and as a nursery for estuarine fish. Upper reaches are seasonal and of no fishery value but lower reaches near the estuary are of importance as a transitional habitat to estuarine fish and European eel
- The River Corrib is an important salmonid river system and is considered to be of International Status with an extremely high attribute value due to its European designation as part of the Lough Corrib cSAC and Lough Corrib SPA
- The Terryland River which continues to be impacted by urban pollution is considered to be of limited fisheries value and categorised to be of local importance (lower value) for European eel
- The Coolagh Lakes is categorised to be of local importance (lower value) for coarse fish species and European eel and despite its connection to the River Corrib is of limited or no value to salmonids
- Ballindooley Lough is considered to be an excellent coarse fishery, but not of importance as a salmonid fishery and is categorised to be of local importance (higher value) for coarse fish species

11.3.6 Surface Water Quality

11.3.6.1 Rivers

EPA Monitoring River Programme

The EPA carries out water quality assessments of rivers as part of a nationwide monitoring programme. Data is collected from physio-chemical and biological surveys, sampling both river water and the benthic substrate (sediment) in contact with the water.

Water sampling is carried out throughout the year and the main parameters analysed include: conductivity, pH, colour, alkalinity, hardness, dissolved oxygen, biochemical oxygen demand (BOD), ammonia, chloride, ortho-phosphate, oxidised nitrogen and temperature.

Biological surveys are normally carried out between the months of June and October. These examine the relationship between water quality and the relative abundance and composition of the macro-invertebrate communities in the sediment of rivers and streams. The macro-invertebrates include the aquatic stages of insects, shrimps, snails and bivalves, worms and leeches. It is generally found that the greater the diversity of species recorded, the better the water quality is.

The collated information relating the water quality and macro-invertebrate community composition is condensed to a numerical scale of Q-values or Biotic Index. The indices are grouped into four classes based on a river's suitability for beneficial uses such as water abstraction, fishery potential, amenity value, etc. (refer to **Table 11.17** below).

Table 11.17: Biological River Water Quality Classification System

Biotic Index (Q value)	Quality Status	Quality Class	Condition
Q5, Q4-5, Q4	Unpolluted	Class A	Satisfactory
Q3-4	Slightly Polluted / Eutrophic	Class B	Transitional
Q3, Q2-3	Moderately Polluted	Class C	Unsatisfactory
Q2, Q1-2, Q1	Seriously Polluted	Class D	Unsatisfactory

The River Corrib is monitored at Wolfe Tone Bridge and is currently categorised as having good status (Q4) for the period (2004 - 2015) and the Terryland River as having poor Status (Q2-3). No Other watercourses within the study area are currently monitored by the EPA as part of the EPA Monitoring River Programme.

11.3.6.2 Lakes

As part of a national water quality monitoring programme, a number of lakes throughout the country are sampled and the trophic status assessed. Lake water quality is most commonly assessed by reference to a scheme proposed by the Organisation for Economic Cooperation and Development (OECD, 1982). This scheme defines the traditional trophic categories by setting boundaries for the annual average values for total phosphorus, chlorophyll and water transparency, and for the maximum and minimum vales of the latter two parameters.

A modified version of these criteria is used in which annual maximum chlorophyll-a concentration is the only parameter used. This has been further subdivided into six water quality categories by reference to the maximum levels of planktonic algae measured during the period (refer to **Table 11.18**). Indicators relating to water quality and the probability of pollution are also shown.

Table 11.18: Trophic Classification Scheme for Lake Waters

Classification Scheme		**Category Description**				
Lake Trophic Category		**Annual Maximum Chl-a (mg/m^3)**	**Algal Growth**	**Degree of Deoxygenation in Hypolimnion**	**Level of Pollution**	**Impairment of Use of Lake**
Oligotrophic	(O)	<8	Low	Low	Very low	Probably none
Mesotrophic	(M)	8 – 25	Moderate	Moderate	Low	Very little
	Moderately (m-E)	25 – 35	Substantial	May be high	Significant	May be appreciable
Eutrophic	Strongly (s-E)	35 – 55	High	High	Strong	Appreciable
	Highly (h-E)	55 – 75	High	Probably total	High	High
Hypertrophic	(H)	>75	Very high	Probably total	Very high	Very high

The trophic status provides an indication as to what degree the lake is enriched by the presence of nutrients such as phosphorus and to a lesser extent nitrogen in the form of nitrate.

Lough Corrib is currently monitored as part of the EPA water quality reporting and is classified as Oligotrophic/Mesotrophic in terms of water quality indicating that nutrient enrichment is low and eutrophication is not a major concern.

11.3.6.3 Baseline Water Quality Sampling of Receiving Waters

Bi-monthly sampling of surface water quality, in the vicinity of the proposed road development, was carried out over a 14month period commencing November 2015 to December 2016. This was carried out to establish baseline water quality conditions in the receiving waters. The sampling locations are as follows:

1. Sruthán na Libeirtí at the R336 Coast Road culvert upstream
2. Trusky Stream East at the R336 Coast Road culvert upstream
3. Bearna Stream at Cappagh North
4. Bearna Stream at Cappagh South
5. River Corrib at Dangan Slip
6. River Corrib at Terryland Intake Channel, Jordan’s Island
7. Upper Coolagh Lake
8. Lower Coolagh Lake
9. Ballindooley Lough

The water quality sampling results are presented in **Appendix A.11.2**. The locations of the sampling points are identified on a set of figures within the appendix. The results show consistently good quality water at all of the sites with nutrient, BOD, sediments and heavy metal concentrations well within acceptable limits based on the surface water regulations. Bacterial faecal contamination was identified at all locations, possibly associated with the presence of agricultural activities, point septic tank and slurry pit sources within the respective catchments.

As expected the western watercourses (Bearna Stream, Trusky Stream and Sruthán na Libeirtí) associated with the granite bedrock and peatland areas showed slightly lower pH, lower alkalinity and hardness and elevated iron concentrations compared to the eastern limestone watercourses. The most alkaline and highest hardness waters were found within Ballindooley Lough followed by the Coolagh Lakes.

11.3.7 Water Supply Sources

11.3.7.1 Galway City Water Supply

The Galway City Water Supply Scheme at Terryland abstracts water from the River Corrib via an intake channel at Jordan’s Island. The Water Treatment plant has recently been upgraded so that it can treat and supply up to 55,000m^3 per day (0.64cumec). The source of this water is from Lough Corrib but also its downstream catchment area, including the Coolagh Lakes outflow to the River Corrib on the eastern bank of the River Corrib. This plant provides full treatment that includes screening, coagulation, flocculation and clarification, followed by gravity filtration, chlorination and UV-disinfection. The Galway City Council / Irish Water objective is to increase this supply and this is likely to require the relocation of the abstraction inlet point into the deeper River Corrib mainline channel possibly to the south of Jordan’s Island.

The source zone of contribution for this abstraction extends upstream and includes River Corrib, Lough Corrib and also includes Coolagh lakes.

The Regional Galway County Water supply abstraction and treatment is from the Lough Corrib at Luimnagh. This abstraction is located over 15km upstream of the proposed road development and therefore not within the zone of influence (ZoI) of the proposed road development.

11.4 Characteristics of the Proposed Development

A detailed description of the proposed road development and construction activities are provided in **Chapter 5, Description of Proposed Road Development** and **Chapter 7, Construction Activities**. This section outlines the characteristics and activities of the proposed road development of relevance to hydrology.

11.4.1 Operational Phase

11.4.1.1 Proposed Watercourse Crossings

Excluding the River Corrib there are a total of 17 stream road crossing sites that will require culverting, 16 of these culvert sites are located in the western section and one in the eastern section. The catchment areas of these watercourses is generally very small ranging from a number of hectares to the largest crossing of the Bearna Stream with an upstream catchment area of 5.5km^2. The majority of these watercourses flow in a southerly direction discharging into Galway Bay. The watercourses to the east of the Bearna Stream discharge to the designated Galway Bay Complex cSAC and watercourses to the west of the Bearna Stream discharge to Galway Bay outside of this cSAC. These watercourse crossings are summarised below in **Table 11.19**.

The proposed road development will involve a new bridge crossing of the River Corrib channel at Menlough/Dangan.

Table 11.19: Proposed Watercourse Crossing Locations

Culvert Reference	X	Y	Approx. Chainage	Catchment Area km^2	Qdesign cumec	Watercourse	Ecological Evaluation
C00/01	521325	723182	0+650	0.47	1.26	Sruthán na Libeirtí	Local Lower at site and downstream
C00/02	521522	723446	1+000	0.32	0.89	Sruthán na Libeirtí	Local Lower at site and downstream
C01/01	521984	723779	1+500	0.06	0.09	Small coastal stream	None
C02/01a	523087	724284	2+800	1.19	1.63	Trusky Stream	Local Higher downstream
C02/01b	523180	724198	2+850	1.19	1.63	Trusky Stream	Local Higher downstream
C03/01	523354	724244	3+050	0.08	0.12	Trusky minor drain	Local Higher downstream
C03/02	523616	724390	3+350	0.15	0.23	Trusky minor drain	Local Higher downstream
C03/03 C03/04	524066 524079	724706 724722	3+925 3+940	0.69	1.09	Bearna Tributary	Local Higher downstream
C04/01	524202	724846	4+100	5.49	7.58	Bearna Stream	Local Higher at site and downstream
C04/02	524895	725274	4+900	1.65	2.13	Tonabrocky	Local Higher downstream
C06/01	526421	726389	6+850	0.14	0.20	Knocknacarra Minor Drain	Local Higher downstream
C07/02B	526710	726684	7+250	0.21	0.30	Knocknacarra Minor Drain	Local Higher downstream
C07/02A	526698	726637	7+210	0.21	0.30	Knocknacarra Minor Drain	Local Higher downstream
C08/01	527664	727212	8+375	0.16	0.23	Minor Drain Dangan	Corrib SAC downstream
C10/02	529688	728412	10+730	0.63	0.19	Minor Drain Coolagh	Corrib SAC downstream
C07/01a	527148	726262	N59 Link Road south 1+600	0.38	0.55	Knocknacarra Minor Drain	Local Higher downstream
S08/04			9+250	3134	264	River Corrib	Corrib SAC downstream

The design flow presented in the above table includes the best flood flow estimate using either IH124 or the Flood Studies Update (FSU, 2015) method and multiplied by the factorial standard error of the equation and increased a further 20% to include for climate change allowance. Further details of the culvert crossings are discussed in **Section 11.5.3.1**.

11.4.1.2 Hydraulic Structures

Culverts

Table 11.20 summarises the propose crossing sizes, effective height and associated embedment depths for each of the proposed culverts at the crossing of watercourses.

Table 11.20: Preliminary Sizing of Watercourse -Crossing Culverts

Ref.	Approx. Chainage	Width (m)	Height (m)	Diameter	Buried Depth	Effective Height	Watercourse
C00/01	0+650	2.5	1.35		0.30	1.05	Sruthán na Libeirtí
C00/02	0+950			1.2	0.15	1.05	Sruthán na Libeirtí
C01/01	1+500			1.2	0.15	1.05	Small coastal stream
C02/01a	2+800	2.1	1.8		0.30	1.5	Trusky Stream
C02/01b	2+825	2.5	2.5		0.30	2.2	Trusky Stream
C03/01	3+050	2.5	1.2		0.30	0.9	Trusky minor drain
C03/02	3+350			0.9	0.00	0.9	Trusky minor drain
C03/03	3+925	2.5	2.5		0.30	2.2	Bearna Tributary
C03/04	3+940	2.5	2.5		0.30	2.2	Bearna Tributary
C04/01	4+100	5.0	2.5		0.30	2.2	Bearna Stream
C04/02	4+900	3.1	2.5		0.30	2.2	Tonabrocky
C06/01	6+850	2.5	2.5		0.30	2.2	Knocknacarra Drain
C07/02B	7+250			1.2	0.15	1.05	Knocknacarra Drain
C07/02A	7+210	2.5	2.5		0.30	2.2	Knocknacarra Drain
C08/01	8+375			1.2	0.00	1.2	Minor Drain Dangan
C10/01	10+730			1.2	0.15	1.05	Minor Drain Coolagh

Ref.	Approx. Chainage	Width (m)	Height (m)	Diameter	Buried Depth	Effective Height	Watercourse
C07/01	N59 link			1.2	0.15	1.05	Knocknacarra Drain

Notes:

1. Suitable channel transition to and from culvert to be provided that allows for gentle flow transition into and from the culvert and protects against scour and deposition effects.
2. The sizes indicated above are full sizes inclusive of any increases required to accommodate depressed inverts or mammal ledges.

The above crossing sizes allow for pipe culverts and box section inverts to be buried beneath the existing bed level by depths of 150mm in respect to pipes and 300mm in respect to the box sections in fishery watercourses. All other watercourses (non-fisheries) traversed by the proposed road development are minor in flow requirements and therefore can be culverted using a standard nominal 1200mm or 900mm diameter concrete pipe or equivalent.

All of these culverts have been designed for the 100year flood and climate change allowance such that the impact on flood risk is rated at slight with a moderate residual flood risk associated with potential blockage by debris of the culvert barrel, inlet or outlet structures. The proposed regular maintenance and inspection program of the road drainage infrastructure minimises this residual flood risk impact reducing the flood risk to slight.

Under Section 50 of the Arterial Drainage Acts 1945 and 1995, culverting of streams by either new, upgraded or extended culverts/bridges requires approval from the OPW. This enables the OPW who are responsible for Flood Risk Management and Arterial Drainage to assess the implications of the proposed works. The minimum culvert size to be used in relation to the natural drainage is a 1200mm diameter pipe culvert which facilitates burying of the pipe by 150mm. From a hydraulic capacity, blockage potential and maintenance point of view, this minimum culvert size is acceptable and easily meets the OPW requirements. Section 50 approval has been obtained from the OPW in respect to all proposed watercourse culvert crossings described in **Table 11.20** above.

All culverts are designed to prevent permanent impact to the river morphology. A short term temporary impact may occur whilst on-line culverts are put in place. These impacts will be minimised through the incorporation of strict control procedures – refer to the Construction Environmental Management Plan (CEMP) in **Appendix A.7.5**. Permanent impacts on river morphology will be prevented by ensuring the river width is not exceeded or contracted by the proposed culvert or bridge and that reasonable transitions to and from the bridge or culvert is provided where approach and exit channels are skewed to the culvert alignment. In all fishery sensitive watercourses, the proposed culvert will be embedded into the channel to a depth of 300mm for box sections and a minimum of 150mm for pipe culverts (depending on hydraulic size requirements). Suitable local granular material will be placed to back fill the embedded culvert and sizing will be designed based on scour resistance requirements and in consultation with Inland Fisheries Ireland. In all fishery potential streams low flow channels through the culverts will be provided using appropriately sized natural sediments and baffles to assist the formation of such. The design of such measures must take into account the potential for scour.

All Culverts are designed with inlet and outlet structures that include headwall, wing walls and a buried concrete apron or armour stone to resist local scour of the stream bed at the inlet and outlet.

All crossings identified as potential salmonid rivers/streams and important for mammalian (otter) migration have been be designed to maintain the existing migratory routes as far as possible, in accordance with Guidelines for the crossing of Watercourses during the Construction of National Road Schemes, NRA 2008.

The culverts with mammal ledges have been identified and the effect of these ledges has been take into account in the Section 50 assessment.

Channel transitions are required to and from the culvert structure and this may require slight channel realignments to achieve a smooth transition and avoid local erosion and deposition sites due to the culvert.

River Corrib Bridge

The proposed road development crosses the River Corrib to the southwest of Menlo Castle on the eastern side and crosses through NUIG Sporting Campus at Dangan on the western side of the river. The proposed structure is a balanced cantilevered structure spanning over the river banks and provides a clear span between support piers of 153m. This clear span is sufficient to allow the support piers to be set back from the channel bank and thereby substantially reduces any potential encroachment of the River Corrib channel and its flood banks and allows for continuous access along the river bank edge on both banks. On the eastern bank the minimum setback distance from the pier face to channel edge is 5m and on the western bank the minimum setback is slightly more than 10m. Such setbacks meet IFI Fisheries requirements.

The bridge soffit level above the River Corrib Median flood level of 6.26m AOD is 14.1m AOD on the eastern bank edge, 17.8m AOD at the midspan of the channel and 15.5m OD on the western river bank edge. This ensures navigation requirements are easily met and such clearance reduces shadowing effects of the bridge structure.

A detailed hydraulic assessment of the River Corrib and the proposed bridge structure was carried out as part of the Section 50 application for the proposed bridge. This assessment involved development of a detailed 2-dimensional hydraulic model of the River Corrib reach from Menlough to the Salmon Weir and included the Jordan’s Island Channel and the Coolagh Lakes to predict flood levels and allow testing of various bridge configurations as part of the preliminary design and bridge options study. A summary of the predicted design flows and predicted design flood levels are presented in **Table 11.21** below.

Table 11.21: Estimated Design Flood Flows and Flood Levels at the Proposed River Corrib Bridge Crossing

Return Period years	**QT Flood Flow cumec**	**Computed Upstream Flood Level m OD**
2year (Median)	274.5	6.26
10year	389.3	6.72
100year	519.5	7.20
1000year	647.9	7.62
100year+CC	623.4	7.54

11.4.1.3 Proposed Road Drainage Features

There are 16 proposed mainline surface water outfalls discharging directly to surface watercourses, located primarily in the western section of the study area (over the western 10.15km of the mainline for the proposed road development). The remaining surface water outfalls from the 7.35km, to the east of the River Corrib will be discharged to groundwater or to existing public storm and foul sewer systems in the absence of surface water drainage features. The realigned N84 Headford Road and slip roads for the N84 Headford Road Junction will discharge to a small ditch that inflows to Ballindooley Lough. The two short sections of tunnel in the eastern section will discharge to the public foul sewer via pumping. Details of the overall breakdown of the proposed drainage network sections are shown on **Figures 11.6.101** to **11.6.115**.

The total surface drainage area for the proposed road development is estimated to be 94.85ha and the hard-paved area is 61.21ha. This gives the average percentage impervious area for the road of 64.5%. The total drainage area discharging to surface water outfalls is 55.96ha with hard paved area of 32.5ha and the total drainage area discharging to groundwater is 35.5ha with hard paved area of 19.2ha.

The proposed tunnelled sections are relatively short closed systems and the surface drainage from inside the tunnel is gravitated to a sump where it will be collected and discharged by pumping into the nearby public foul drainage system, which eventually arrives at the Mutton Island Waste Water treatment facility, where it is treated and disposed to sea. The tunnelled section will not receive any direct rainfall. An impounding sump of 25m^3, to collect accidental spillages from inside the tunnel is provided for both the Lackagh Tunnel and Galway Racecourse Tunnel.

The paved area contributing to the proposed road development drainage outfalls has an average pavement area of 1.2ha, which represents a reasonably small ratio of pavement area to outfall. The largest surface water outfall serves a paved area of 2.45ha and the largest groundwater outfall serves a paved area of 4.82ha. A summary of the proposed road development drainage outfalls discharging to surface watercourses is presented here in **Table 11.22** and those storm outfalls discharging to groundwater are presented in **Table 11.23**.

Table 11.22: Proposed Road Development Drainage Outfalls to Watercourses

Drainage Network Ref. No.	Approx. Chainage	Total Road Drainage Area (ha)	Road Pavement Area (ha)	Watercourse
S1	0+0000 to 0+700	2.05	1.29	Sruthán na Líbeirtí
S2	0+ 700 to 1+000	0.55	0.38	Sruthán na Líbeirtí
S3	1+000 to 1+475	2.31	1.28	Sruthán na Líbeirtí
S4A	1+475 to 1+900	0.96	0.62	Trusky Tributary
S5A	1+900 to 2+850	2.45	1.53	Trusky Stream
S7A	2+850 to 3+050	0.30	0.24	Bearna Stream
S7B	3+050 to 3+910	2.94	1.07	Bearna Stream
S8	3+910 to 4+125	0.42	0.26	Bearna Stream

Drainage Network Ref. No.	Approx. Chainage	Total Road Drainage Area (ha)	Road Pavement Area (ha)	Watercourse
S9	4+125 to 4+900	1.75	1.19	Bearna Stream
S10	4+900 to 5+640	2.19	1.22	Bearna Tributary
S12	6+325 to 7+300	3.15	2.45	Knocknacarra Tributary
S13	7+300 to 7+525	0.91	0.63	Knocknacarra Tributary
S14A	7+525 to 8+250	5.66	2.199	Discharging to culvert on River Corrib Tributary West Bank
S14B	8+250 to 8+525	0.85	0.65	River Corrib Tributary
S18A	8+525 to 9+250	1.75	1.58	River Corrib Tributary West Bank
S18B	9+250 to 10+150	2.27	1.95	River Corrib Tributary East Bank
S21A	11+850 to 12+450	3.31	1.36	Ballindooley Lough Tributary
S4B	1+500	0.12	0.07	Trusky Tributary
S15	+ N59 Link Road North Chainage 0+000 to 0+625	1.89	0.73	River Corrib Tributary West Bank
S5B	2+800	0.24	0.14	Trusky Stream
S36A	3+350	0.24	0.17	Bearna Tributary
S36B	3+350	0.10	0.08	Trusky Stream
S31A	7+250	0.09	0.06	Knocknacarra Tributary
S31B	7+250	0.15	0.12	Knocknacarra Tributary
S44	9+150	0	0	River Corrib Tributary West Bank

Table 11.23: Proposed Road Development Drainage Outfalls to Infiltration Basins

Drainage Network Ref. No.	Approx. Chainage	Total Drainage Area (ha)	Pavement Area (ha)
S19A	10+150 to 10+730	1.95	1.66
S19B	10+730 to 11+150	2.22	1.68
S20	11+420 to 12+020	4.26	2.23
S21B	12+020 to 13+630	8.28	4.82
S22A	13+360 to 14+350	5.68	3.94
S22B	14+350 to 14+950	3.06	2.76

Drainage Network Ref. No.	Approx. Chainage	Total Drainage Area (ha)	Pavement Area (ha)
S27	16+750 to 17+535	5.47	3.20
S22E	14+400	0.79	0.69
S22C2	14+400	0.83	0.76
S40	10+475	0.16	0.12

The remaining drainage areas discharge to the existing public storm drainage infrastructure. The permissible discharge rates have been set based on consideration of natural greenfield runoff rates and the current capacity in the receiving storm drainage system. All of the proposed discharge rates to public storm sewers have been agreed with Galway City Council. A summary of the outfalls to the public sewer is provided in **Table 11.24** below.

Table 11.24: Proposed Road Development Outfalls to Public Storm Sewers

Drainage Network Ref. No.	Approx. Chainage	Total Drainage Area (ha)	Pavement Area (ha)	Receiving Sewer Size (mm)	Peak discharge rate 1 in 100 (l/s)
S11	5+640 to 6+325	2.02	1.57	300	7.8
S14A	7+525 to 8+250	5.66	2.199	1200	21
S26	15+750 to 16+750	5.12	3.47	900	4.5
S29	16+500	2.73	2.07	900	5.0
S30	15+200 to 15+700 Junction - Coolagh Junction to Lynch Junction	6.33	4.58	900	5.7
S16A	N59 Link Road South 0+625 to 1+625	4.16	2.15	450	16.1
S17A	N59 Link Road South 1+625 to 2+210	1.08	0.98	1500	5.7
S22C1	14+400	1.46	1.36	900	5.0
S37	4+450	0.21	0.19	450	5.4
S32	6+300	0.80	0.40	375	5.6
S16B	N59 Link Road South 1+625	0.12	0.10	450	4.7
S17B	N59 Link Road South 2+210	0.34	0.27	1500	5.2
S31C	7+250	0.25	0.16	450	4.9
S38	5+650	0.14	0.10	300	46.7

Drainage Network Ref. No.	Approx. Chainage	Total Drainage Area (ha)	Pavement Area (ha)	Receiving Sewer Size (mm)	Peak discharge rate 1 in 100 (l/s)
S41	13+150	0.24	0.23	225	66.7
S39	7+575	0.22	0.15	225	68.6
S33	1+500	0.56	0.54	600	5
S45	15+200	1.736	1.44	750	241

Proper management and regular inspection and maintenance of these drainage discharge facilities will be undertaken as part of the operation and maintenance schedule during the operational phase of the proposed road development.

All rainfall runoff will be prevented from discharging directly to the receiving surface waters by the proposed road sustainable drainage system. Road runoff will only outfall to receiving surface waters at specified outfall locations. Catchment sizes are conserved as far as practicable by minimising diversion of run-off between sub-catchments. Attenuation ponds, treatment wetlands oil / petrol interceptors and silt traps will be installed at all major outfalls, to prevent pollutants from entering the receiving watercourses. The installation of emergency spill containment facilities with a minimum volume of 25m^3 will mitigate against any potential adverse impacts to the receiving surface waters arising from an accidental spillage associated with road haulage.

Attenuation storage and flow control have been provided for all mainline and new link road drainage areas so that the design flood discharge in the case of surface discharges achieves predetermined greenfield flood runoff rates. This prevents potential impacts to river morphology and surface water flow hydraulics of the receiving watercourses. In the case of groundwater, the storm water disposal rates meet the infiltration capacity of the infiltration basin. The proposed attenuation storage volumes are sized accordingly to accommodate any potential increase in surface water runoff rates up to the 100year return period storm event with climate change allowance. This ensures that there will be no increase to flood risk up to and including the 1 in 100year storm event as per TII drainage publications Clause 7.5 of DN-DNG-03022 Drainage Systems for National Roads. A departure from this standard applies to the two River Corrib outfalls (S18A and S18B) located on either bank, where flood attenuation is not necessary due to the significant difference in drainage catchment scale (with the River Corrib catchment over 70,000 times bigger) and timing of flood response (hours versus days). All outfall structures will be designed with an outlet structure that includes headwall, wing walls and a bed apron to prevent local scouring of the banks and the channel bed. All culverts are designed to allow for both aquatic species and mammal migration, and to maintain the existing river bed as far as possible, in accordance with “Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes,” NRA, 2008. All culverts upstream and downstream of protected ecological areas (NHAs, SACs or SPAs) are designed to retain natural riverbed forms. **Section 11.4.1.1** discusses in greater detail the requirements of culverting for the protection of local ecology.

All culverts and the River Corrib Bridge are designed accordingly to prevent impact to watercourse morphology and to prevent impoundment or alteration of surface water flow hydrodynamics. All watercourse culverts and the River Corrib Bridge have obtained Section 50 approval from the OPW and therefore satisfy the OPW Flood Risk and impact requirements. For further details, refer to the Flood Risk Assessment Report in **Appendix A.11.1**.

The proposed River Corrib Bridge crossing is designed to prevent impact to the hydrodynamics of the river and its associated floodplain. It has been designed so as not to have any piers located within the effective floodplain area, within the channel, or within 5m of the river banks. The bridge is located in a stable, straight, reach section of the river (as evidenced by bankside vegetation), so it is expected to neither be sensitive to, nor impact on, local channel morphology.

No major river realignment work will be necessary as part of the proposed road development. Some minor stream and ditch realignment is required. The minor drain and stream diversions proposed for the proposed road development are summarised in **Table 11.25** below.

Table 11.25: Minor Watercourse Diversions

Stream	Approx. Chainage	Diversion Channel Length (m)	Location
Sruthan na Liberiti	0+700	35	Na Foraí Maola
Truskey Stream	2+800	50	Bearna to Moycullen Road
Tributary to Bearna Stream	3+375 to 3+900	525	Aille
Tonabrocky Stream	4+960 to 5+200	240	Keeraun
Drain	7+200 to 7+350	320	Letteragh Road

The proposed stream and drain realignments have been assessed as part of the culvert design. Localised design measures are included to prevent potential bank erosion at sites of bends which were found to coincide with a number of the proposed road culverts. This protection may be in the form of large boulders or rip-rap along the outer bank with a suitable filter material or geotextile placed inside the armouring to protect the native soil bank. All diversion channels will include fishery friendly requirements where they are identified as having fishery potential.

This may require the incorporation of meanders, riffles/shoals and pools within the channel bed and suitable sediment size provided within the new channel to resist scour under flood flow conditions. The flood capacity will be enhanced while importantly preserving the low flow channel characteristics. The inclusion of shoals and pools in the channel will assist the rehabilitation of the low flow channel at crossing and diversion/realignment sites. All stream re-alignment work shall create new channels that will achieve maximum ecological benefits and maintain or improve on the existing hydrological environment. The design of stream re-alignments was conducted in consultation with Inland Fisheries Ireland to ascertain their desired stream morphology to adequately address fishery habitats and passage. The principle aim of stream re-alignment is to promote ecology and ensure a more suitable stretch of stream for fisheries. Stream realignment will be conducted using the principles and guidance laid out by the Central Fisheries Board for the enhancement of rivers (O'Grady, 2006).

The use of persistent herbicides, pesticides or artificial fertilisers in any landscaping or subsequent maintenance within 2m of a watercourse is not permitted. Applications of herbicides or pesticides within a zone of 2m to 10m from any watercourse will be in accordance with manufacturer's recommendations and confined to periods when the vegetation is not wet from rainfall or dew.

11.4.1.4 Pollution Control Measures

The proposed drainage system design incorporates a range of pollution control features to limit the water quality impact to receiving waters. These include combined filter drains, detention ponds, grassed surface water channels, petrol and oil interceptors, wetlands and infiltration basins. The use of filter drains and grassed surface water channels are proposed in non-sensitive groundwater areas (granite bedrock areas west of N59 Moycullen Road) and closed (sealed) drainage systems are proposed in the highly vulnerable Karst Aquifer region east of the N59 Moycullen Road. A Treatment wetland will also be provided upstream or in combination with the attenuation pond at all proposed surface outfalls from the proposed mainline and new link road catchments and upstream of all infiltration basins, to provide primary treatment of road runoff. These wetlands systems will be suitably planted with aquatic plants for uptake of solutes including dissolved heavy metals and nutrients and will have a permanent pond depth of at least 500mm. A summary of the pollution control measures provided at each drainage outfall is summarised in **Table 11.26** below.

Table 11.26: Pollution Control Summary

Drainage Network Ref. No.	Outfalling to	Pollution Control Measure Provided
S1	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S2	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S3	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S4A	Watercourse	Spillage Containment Area, Oil and petrol interceptor, Wetland, Attenuation Pond
S5A	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S7A	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S7B	Watercourse	Spillage containment Area, Oil and petrol interceptor, Wetland, Attenuation Pond
S8	Watercourse	Spillage containment Area, Oil and petrol interceptor, Wetland, Attenuation Pond

Drainage Network Ref. No.	Outfalling to	Pollution Control Measure Provided
S9	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S10	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S11	Existing Sewer	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S12	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S13	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S14A	Existing Culvert	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S14B	Watercourse	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S18A	Watercourse	Spillage Containment Pipes, Oil and Petrol Interceptor, Wetland
S18B	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland
S19A	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
S19B	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
F19	Foul Sewer	Spillage Containment Area, Oil and Petrol Interceptor discharging to Foul Sewer. Discharge to be treated at Mutton Island Waste Water Treatment Works.
S20	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
S21B	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
S22A	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
S22B	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
F24	Foul Sewer	Spillage Containment Area, Oil and Petrol Interceptor discharging to Foul Sewer. Discharge to be treated at Mutton Island Waste Water Treatment Works.
S26	Existing Sewer	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S27	Existing M6 Infiltration Basin	Existing M6 Infiltration Pond
S21A	Attenuation Basin	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond

Drainage Network Ref. No.	Outfalling to	Pollution Control Measure Provided
S22E	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Infiltration Basin
S29	Existing Sewer	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S30	Existing Sewer	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S4B	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S15	Watercourse	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S16A	Existing Sewer	Spillage Containment Area, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S17A	Existing Sewer	Spillage Containment Pipe, Oil and Petrol Interceptor, Wetland, Attenuation Pond
S22C1	Existing Sewer	Spillage Containment Pipe, Oil and Petrol Interceptor, Attenuation Pond
S22C2	Infiltration Basin	Spillage Containment Pipe, Oil and Petrol Interceptor, Infiltration Basin
S5B	Watercourse	None Required, overlay of existing local road
S16B	Existing Sewer	Online Attenuation – Flow Control and Oversized Pipes
S17B	Existing Sewer	Online Attenuation – Flow Control and Oversized Pipes
S31A	Watercourse	None Required, overlay of existing local road
S31B	Watercourse	None Required, overlay of existing local road
S31C	Existing Sewer	Online Attenuation – Flow Control and Oversized Pipes
S32	Existing Sewer	Attenuation Pond
S33	Existing Sewer	Attenuation Tank
S36A	Watercourse	None Required, upgrade of existing local road
S36B	Existing Ditch	None Required, overlay of existing local road
S37	Existing Sewer	Online Attenuation – Oversized Pipes
S38	Existing Sewer	None Required, overlay of existing local road
S39	Existing Sewer	None Required, overlay of existing local road
S40	Infiltration Basin	Spillage Containment Area, Oil and Petrol Interceptor, Infiltration Basin
S41	Existing Sewer	None Required, overlay of existing local road
S44	Watercourse	None Required, synthetic playing pitch development only
S45	Existing Sewer	None Required, brown field development

Each of the mainline and new link road catchment attenuation ponds either includes or have immediately upstream a wetland treatment system which has been sized to cater for the first flush volume from the proposed road pavement (15mm rainfall event).

The attenuation ponds are sized to cater for the 100year storm event with 20% climate change allowance and discharge at the permissible greenfield flood outflow rate subject to a minimum discharge rate of 5l/s. These storages provide large detention times that allow effective settlement of sediments within the pond systems.

Spillage containment will be achieved using oil and petrol interceptors sized for the individual drainage catchment and located upstream of the wetland and attenuation ponds / infiltration basins to prevent any contamination from hydrocarbons entering the surface and groundwater systems. A minimum emergency spill containment volume of 25m^3 will be provided at all outfall locations where runoff can be diverted in the event of a spillage from a HGV.

To facilitate emergency response to serious spillages all pond and storage systems will be fitted with a manual penstock to close off the outfall and contain the spillage water within the pond/storage system for pumping out and appropriate treatment and disposal. Access will be provided to these facilities to enable ongoing inspection, maintenance and emergency response.

11.4.1.5 Material Deposition Areas

A total of 40 site areas have been identified as potential material deposition areas for the excess soft and unacceptable material along the route of the proposed road development. These sites are all within easy haulage distances from the location of large soft ground deposits and are detailed in the **Table 11.27** below. These sites provide a storage capacity in excess of the anticipated 370 thousand cubic metres of potentially excess unacceptable material which may be encountered along the proposed road development. Each area has been assessed, however they will not be fully utilised as there is excess capacity.

Table 11.27: Location of Potential Material Deposition Areas

Location	Approx. Chainage	Catchment Reference	Area (ha)	Approximate Capacity (m^3)
R336 Coast Road	0+050	Sruthán na Líbeirtí	0.089	1,200
An Baile Nua	0+300	Sruthán na Líbeirtí	0.232	3,200
Cnoc na Gréine	0+350	Sruthán na Líbeirtí	0.248	2,700
Na Foraí Maola Thiar	1+050	Sruthán na Líbeirtí	0.098	<1,000
Na Foraí Maola Thoir	1+450	Sruthán na Líbeirtí / Trusky Stream	1.051	<1,000
Troscaigh Thiar	1+800	Trusky Stream	0.483	7,800
Bearna to Moycullen Road	2+900	Trusky Stream	0.065	<1,000

Location	Approx. Chainage	Catchment Reference	Area (ha)	Approximate Capacity (m^3)
Bearna to Moycullen Road	2+950	Trusky Stream	0.602	11,400
An Chloch Scoilte	3+250	Trusky Stream	0.239	4,000
An Chloch Scoilte	3+375	Bearna Stream	0.154	<1,000
An Chloch Scoilte	3+950	Bearna Stream	0.349	10,000
An Chloch Scoilte	4+050	Bearna Stream	0.468	10,000 2,100
Cappagh	4+850	Bearna Stream	0.121	
Ballymoneen	5+250	Bearna Stream	0.811	10,700
Keeraun	5+950	Knocknacarra Stream	0.484	2,500
Letteragh	7+450	Knocknacarra Stream	0.308	5,000
Bushypark	0+050	River Corrib Catchment incl. Terryland River Valley	0.079	<1,000
Bushypark	0+075	River Corrib Catchment incl. Terryland River Valley	0.393	2,200
Bushypark	0+200	River Corrib Catchment incl. Terryland River Valley	0.353	6,000
Dangan	8+100	River Corrib Catchment incl. Terryland River Valley	0.149	<1,000
Dangan	8+200	River Corrib Catchment incl. Terryland River Valley	0.069	<1,000
Coolough	10+675	River Corrib Catchment incl. Terryland River Valley	0.142	<1,000
Lackagh Quarry	11+000	River Corrib Catchment incl. Terryland River Valley	1.727	45,000
Lackagh Quarry	11+350	River Corrib Catchment incl.	2.936	200,000

Location	**Approx. Chainage**	**Catchment Reference**	**Area (ha)**	**Approximate Capacity (m^3)**
		Terryland River Valley		
Lackagh Quarry	11+450	River Corrib Catchment incl. Terryland River Valley	0.148	<1,000
Lackagh Quarry	11+500	River Corrib Catchment incl. Terryland River Valley	0.160	<1,000
Lackagh Quarry	11+550	River Corrib Catchment incl. Terryland River Valley	0.346	
Lackagh Quarry	11+650	River Corrib Catchment incl. Terryland River Valley	1.180	250,000
Ballinfoyle	12+200	River Corrib Catchment incl. Terryland River Valley	0.208	5,700
Ballinfoyle	12+225	River Corrib Catchment incl. Terryland River Valley	0.359	7,300
Twomileditch	14+000	River Corrib Catchment incl. Terryland River Valley	3.024	25,000
Parkmore	13+950	River Corrib Catchment incl. Terryland River Valley	0.315	<1,000
Parkmore	13+950	River Corrib Catchment incl. Terryland River Valley	0.195	<1,000
Coolagh	16+000	Doughiska	0.395	7,000
Coolagh	16+400	Doughiska	0.853	10,000
Coolagh	16+550	Doughiska	1.789	11,500
Coolagh	16+350	Doughiska	1.941	63,000
Coolagh	16+450	Doughiska	0.440	18,000
Coolagh	16+500	Doughiska	0.782	35,000

These material deposition areas will be bunded or excavated sites and will have double erosion control fencing (silt fence) and a sediment settlement pond at the outlet which will be constructed in advance of their use as deposition areas. In addition, wheel wash facilities, will be provided at the entrance/exit as outlined in the CEMP – see **Appendix A.7.5**.

A 2.5m wide permanent maintenance access track will extend around the external perimeter of the peat restoration areas and combined with the foundation to the perimeter berm for access. Materials will initially be delivered to the working area for access roads and perimeter berm construction by low ground pressure vehicles such as tracked dumpers and light weight, wide track excavators.

Any local drains within these areas will be either diverted around the site or truncated to minimise the volume of water entering such areas to that of direct rainfall and the soil moisture of the material itself.

11.4.2 Construction Phase

The construction phase of the proposed road development involves temporary and permanent works in the vicinity of and within watercourses, generally associated with the construction of culverts and outfalls, realignment of drainage channels. The aspects of the construction phase that are relevant to hydrology are summarise below.

- Construction of 17 new culverts on watercourse crossings, refer to **Table 11.20** above
- Construction of all 25 road drainage outfalls discharging to surface water outfalls refer to **Table 11.22** above
- Construction of 10 road drainage outfalls discharging to groundwater via infiltration basins, refer to **Table 11.23** above
- Construction of 17 outfalls discharging to existing Public Storm sewer, refer to **Table 11.24** above
- Construction of 5 minor watercourse diversions, refer to **Table 11.25** (ranging in length from 35m to 525m)
- Construction of a new bridge over the River Corrib
- Construction of two tunnel sections at Lackagh Quarry and at Galway Racecourse
- General construction earthworks adjacent to watercourses including the construction of a replacement 3G all weather pitch and training pitch at NUIG Sporting Campus at Dangan
- Construction of wetland treatment systems, attenuation ponds and infiltration basins upstream of the proposed road drainage outfall
- Construction of permanent interceptor drains
- Construction of the proposed road drainage network including carrier drains, filter drains, grassed surface water channels
- Construction of retaining walls along route of the proposed road development

- Construction of flood relief mitigation measures at the N83 Tuam Road crossing location
- Construction of 13 site compounds within the proposed development boundary as set out in **Table 7.9** and shown on **Figures 7.101** to **7.123**
- Construction of material deposition areas - the provision of 40 material deposition sites along the route for surplus topsoil, U1 material (material that does not comply with the requirements outlined in TII Series 600 Cl. 601.1) and peat encountered during construction with the majority of peat material encountered on the west side of the River Corrib. Such material is not suitable as construction material and is excess material
- Construction of temporary drainage works such as sedimentation ponds and silt traps as required to treat soiled construction water. Temporary diversions and interceptor drains will be constructed to reduce the potential for soiled water runoff from the construction site. For further details of control of sediment and erosion refer to the CEMP in **Appendix A.7.5**

11.5 Evaluation of Impacts

11.5.1 Introduction

Given the scale and nature of the proposed road development there are potential significant impacts to the hydrological regime both during their construction and on-going operation. Consequently, detailed measures have been designed and incorporated to ensure that all potential significant impacts are avoided or mitigated.

The principal potential hydrological impacts to the character of the receiving waters are associated with the proposed crossing points and the potential for sediment loading and associated road drainage pollutants entering such watercourses during both construction and operational phases.

There is also potential for impacts to surface water hydrology from other sources which include:

- Impact to surface watercourses crossed by the proposed road development involving culvert and bridge structures and associated realignment of the watercourse channel
- Impact to surface watercourses discharged to via proposed road drainage outfalls and downstream impacts
- Impact to potential morphological changes to watercourses at channel crossings and proposed road development outfall discharge locations
- Impact to flooding and flood risk, upstream and downstream of proposed crossing points and floodplain encroachment at proposed crossing points, at material deposition areas and downstream impacts from storm outfall locations
- Impacts on sites of ecological importance in proximity to surface watercourses namely the River Corrib, Coolagh Lakes and Ballindooley Lough

- Impacts on Galway City public drinking water abstraction from the River Corrib at Jordan’s Island, which is located in the downstream reach from the proposed road development crossing of the River Corrib

11.5.2 Do Nothing Impact

In the event of the proposed road development not being constructed there would be no resulting impacts on the hydrology along the route of the proposed road development. The traffic will remain on the existing road network, which for many of the existing outfalls do not include a sustainable urban drainage system to protect surface and groundwater bodies from pollution and flood runoff.

11.5.3 Potential Impacts to Hydrological Receptors

Construction activities pose a significant risk to watercourses particularly from contaminated surface water runoff from construction activities entering nearby watercourses.

Construction activities within and alongside surface waters associated with bridge and culvert construction, outfalls and channel diversions can contribute to the deterioration of water quality and can physically alter the stream/river bed and bank morphology with the potential to alter erosion and deposition rates locally and downstream. Activities within or close to the watercourse channels can lead to increased turbidity through re-suspension of bed sediments and release of new sediments from earthworks. Consequently, in-stream works can potentially represent a severe disruption to aquatic ecology.

The main contaminants arising from construction runoff include:

- Elevated silt/sediment loading in construction site runoff. Elevated silt loading can lead to long-term damage to aquatic ecosystems by smothering spawning grounds and gravel beds and clogging the gills of fish. Increased silt load in receiving watercourses stunts aquatic plant growth, limits dissolved oxygen capacity and overall reduces the ecological quality with the most critical period associated with low flow conditions. Chemical contaminants in the watercourse can bind to silt which can lead to increased bioavailability of these contaminants
- Spillage of concrete, grout and other cement based products. These cement based products are highly alkaline (releasing fine highly alkaline silt) and extremely corrosive and can result in significant impact to watercourses altering the pH, smothering the stream bed and physically damaging fish through burning and clogging by the fine silt of gills
- Accidental spillage of hydrocarbons from construction plant and at storage depots / construction compounds
- Faecal contamination arising from inadequate treatment of on-site toilets and washing facilities

11.5.3.1 Hydraulic Structures

This sub-section considers the hydraulic impact of the proposed watercourse structures and stream realignments along the proposed road development.

Culvert Crossings

Table 11.19 presents a summary of the primary culvert crossings including upstream contributing catchment area and **Table 11.20** presents the proposed culvert sizes.

The majority of the streams intercepted have relatively small catchment areas and the recommended barrel dimension size provided is generally an increase over existing structures and stream channel dimensions and will not result in any significant contraction of the stream flow velocity or creation of upstream afflux. In a lot of cases the culvert dimensions have been increased to facilitate bat passage and mammal ledges. The Section 50 assessments show that all culverts provided are suitably sized to prevent any potential flood impacts both under present day statistics and in the short to medium term climate change conditions.

These structures can also have a negative impact on the flow regime in watercourses particularly those with fishery potential as often the wider dimension or increased channel gradients can locally result in insufficient water depth during mean and low flow conditions and such structures if not appropriately designed can lead to undesirable changes in channel morphology and thus potentially impact fish migration and sedimentation. The construction of these structures in watercourses, if not carefully managed, can lead to pollution of the watercourse both locally and in its downstream reaches through the potential for spillages from construction plant and equipment and potential release of cement based products, wood preservative from roadway timber fencing and the disturbance of bed and channel banks resulting in suspended sediment releases.

Without appropriate design measures the potential operational impact on hydrology and channel morphology is classified as slight for Local Low fishery watercourses and moderate for Local High watercourses. This is based on the fact that most of the streams are to be culverted are classified as locally higher value for fish in their downstream reaches. It is noted that all of the watercourses are valued as having Local High ecological value.

The potential constructional impacts without mitigation through potential release of sediments by disturbance of the channel bed and bank represent a short term local moderate to significant impact on water quality and bed sediment deposition rates that could impact fishery habitat potential of the downstream reach. As a result all construction works are to be carried out in accordance with OPW, EPA and IFI guidelines at appropriate times of the year and are to implement all necessary measures to limit the potential impact of the works on all stream/river ecology.

A summary of both operational and construction impact due to watercourse crossings is provided in **Table 11.28** below.

Table 11.28: Impact Assessment of Proposed Watercourse Culvert crossings

Ref.	Watercourse	Construction Phase Impact magnitude	Operational Phase Impact Magnitude
C00/01	Sruthán na Libeirtí	Short-term potential moderate impact on water quality and siltation locally and downstream reach	moderate local impact on channel flow regime and morphology
C00/02	Sruthán na Libeirtí	Short-term potential moderate impact on water quality and siltation locally and downstream reach	moderate local impact on channel flow regime and morphology
C01/01	Small coastal stream	Sort-term potential slight impact on water quality and siltation	slight local impact on channel flow regime and morphology
C02/01a	Trusky Stream	Short-term potential moderate impact on water quality and siltation in its downstream reach	moderate local impact on channel flow regime and morphology
C02/01b	Trusky Stream	Short-term potential moderate impact on water quality and siltation in its downstream reach	moderate local impact on channel flow regime and morphology
C03/01	Trusky minor drain	Short-term potential moderate impact on water quality and siltation in its downstream reach	slight local impact on channel flow regime and morphology
C03/02	Trusky minor drain	Short-term potential moderate impact on water quality and siltation in its downstream reach	slight local impact on channel flow regime and morphology
C03/03	Bearna Tributary	Short-term potential moderate impact on water quality and siltation locally and downstream reach	slight local impact on channel flow regime and morphology
C03/04	Bearna Tributary	Short-term potential moderate impact on water quality and siltation locally and downstream reach	slight local impact on channel flow regime and morphology
C04/01	Bearna Stream	Short-term potential significant impact on water quality and siltation locally and downstream reach	moderate local impact on channel flow regime and morphology
C04/02	Tonabrocky	Short-term potential moderate impact on water quality and siltation locally and downstream reach	moderate local impact on channel flow regime and morphology
C06/01	Knocknacarra Drain	Short-term potential slight impact on water quality and siltation	slight local impact on channel flow regime and morphology
C07/02B	Knocknacarra Drain	Short-term potential slight impact on water quality and siltation	slight local impact on channel flow regime and morphology

Ref.	Watercourse	Construction Phase Impact magnitude	Operational Phase Impact Magnitude
C07/02A	Knocknacarra Drain	Short-term potential slight impact on water quality and siltation	slight local impact on channel flow regime and morphology
C08/01	Minor Drain Dangan	Short-term potential slight impact on water quality and siltation	slight local impact on channel flow regime and morphology
C10/01	Minor Drain Coolagh	Short-term potential slight impact on water quality and siltation	slight local impact on channel flow regime and morphology
C07/01	Knocknacarra Drain	Short-term potential slight impact on water quality and siltation	slight local impact on channel flow regime and morphology

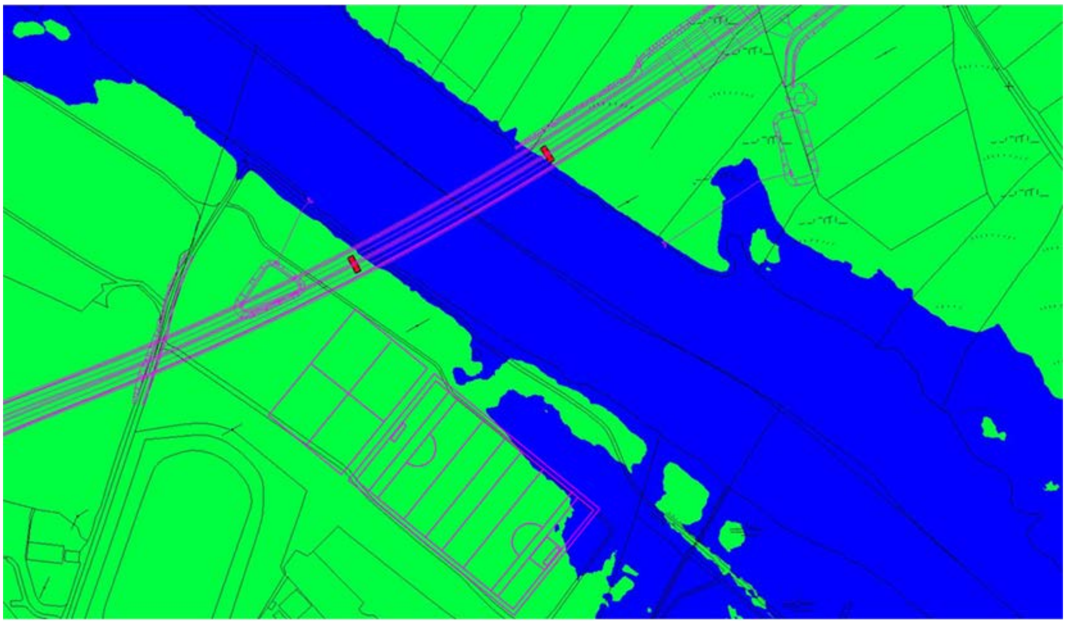
River Corrib Bridge Crossing

For the operational phase, the hydraulic modelling of return period flood flows (with inclusion for statistical error) provided estimates of flood levels at the proposed bridge site. Refer to **Table 11.26** above. This clearly demonstrates that the proposed bridge structure has no discernible impact on flood levels either upstream or downstream nor is there any flood risk issues for the proposed road development with the proposed bridge deck and the storm drainage system sufficiently elevated.

Hydraulic analysis shows no discernible impact on flood levels at the design flood event which is the 100year with inclusion of a climate change allowance of 20%. The predicted flood level for this design flood condition (100yr +CC) is 7.54m OD. At such a flood level, both river bank piers will be located just outside of the flood risk area. At the estimated 1000year flood level of 7.62m OD associated with a peak flood flow of 648cumec, the proposed bridge piers remain outside floodplain area in Flood Zone C, refer to **Plate 11.1** below and therefore no encroachment of the floodplain area will occur at the bridge crossing. The water quality / attenuation ponds remain outside the flood zone also.

There is little potential for bank erosion at the proposed River Corrib crossing location as the river channel is straight, regular and cut into bedrock.

Plate 11.1: 1 in 1,000 year return period flood inundation map of proposed bridge crossing with pier locations shown in red outside of the flood zone



During the construction phase, in order to avoid any potential scour risk associated with the construction of these bridge structures, abutments for bridges are sufficiently set back from the channel bank edge with foundations located at depth. This will protect the river channel from changes in morphology whereby the channel over time would naturally migrate towards one of the abutments. The proposed construction method for the River Corrib bridge crossing will essentially avoid works within the river channel, temporary or otherwise except for the installation of drainage outfalls 18A and 18B. The main risk will be associated with the construction of the support piers adjacent to the channel bank edge which are setback at least 10m on the western bank and 5m on the eastern bank. The River Corrib is sensitive as a salmonid river, major water supply source, European site designation and an important amenity, both locally and downstream through the city and canals. Potential construction accidental spillages of hydrocarbons from plant and spillage of concrete and associated chemicals with constructing the river side piers, bridge deck and storms outfalls represents a potential temporary impact to the waterbody and places risk to the water supply of Galway City, particularly activities on the eastern (left) bank and therefore is categorised as a potential moderate to significant impact in the absence of mitigation measures to protect the River Corrib from construction related pollution in the form of accidental spillages and soiled construction water runoff.

Construction sediment releases from construction activities associated with the bridge crossing represents a potential temporary impact on the River Corrib water quality both locally and downstream. The potential sediment plume will generally hug the river bank edge for quite a distance downstream (approximately 1 to 2km) before fully mixing across the channel width. There is generally good dilution in the River Corrib throughout the year to minimise the wider impact of sediment releases on fisheries, benthos and on the public water supply source. The low velocities associated with the River Corrib and particularly along its river edge provides the opportunity for released construction sediment to settle out rapidly along the bank edge giving rise to the potential for local smothering of the benthos.

Extensive earthworks will be associated with the development of the NUIG pitches at Dangan and given their close proximity to the River Corrib bank edge and to a local drain that discharges to the River Corrib a short distance downstream and the potential for partial flood inundation at the 100year flood a potential for construction runoff pollution of the River Corrib exists. Construction phase mitigation measures are required to protect the sensitive River Corrib waters.

There is a potential for construction impacts on the Coolagh Lakes and supporting habitat from construction site sediment runoff and construction spillages. The natural wetland habitat in the riparian zone of the lakes provides a good buffer between the construction area and the lakes. Notwithstanding this buffer zone, construction phase mitigation measures in the form of sediment and pollution control measures are required to protect this sensitive waterbody.

Mitigation which is outlined in the **Section 11.6** addresses these potential construction impacts through the proposed implementation of good construction practice procedures and environmental controls so as to minimise the opportunity for contaminated releases of construction water to the River Corrib, refer to the CEMP in **Appendix A.7.5**.

11.5.3.2 Stream Diversions and Realignments

The construction of watercourse crossings for the proposed road development will necessitate in some cases the localised diversion/realignment of the existing watercourses. Where feasible, these minor watercourse diversions/realignments will be carried out in the dry and when the channel has established, the watercourse will be diverted into them. The principal impact on a watercourse by a diversion is the change in the watercourse morphology. The general potential impacts can be:

- Slacker gradients: Slower flow velocities with resulting increased flow area and deposition, siltation promoting vegetation and weeds to grow in channels during periods of low flow
- Steeper gradients: Faster flow velocities, increased local bed erosion, shallower low flow depth
- Sharp bends and change in direction: Erosion and deposition with subsequent changes to the river channel morphology
- Lack of natural flood plains: Increase in upstream flood levels

Other potential impacts of watercourse diversions include:

- Change to natural low flow channels: Impact on fisheries and other animals
- Change to existing foliage and vegetation: Impact on fisheries and other species (otters, badgers etc.)

Stream diversions/realignments are not proposed on any locally sensitive salmonid streams. Details of the proposed stream diversions and realignments are presented in **Table 11.23** above. None of these realignments/diversions represent a transfer of stream flow between basins and are only local realignments to facilitate the proposed road development.

It is likely that all the proposed culverts will require some slight local channel realignment and regrading to facilitate the proposed road culvert barrel and to ensure gentle transition to and from the culvert and such transitions have been assessed as part of the culvert crossing assessment in **Table 11.28**.

The principal impact of these channel realignments is associated with the construction stage and the potential for soil erosion associated with the initial excavation works and the initial establishment of the flow channel. This soil erosion may give rise to potential water quality impacts and sedimentation downstream in the receiving waters, most of which are salmonid and of a local higher ecological value in their lower reaches. Therefore, in the unmitigated case, the potential impact of the constructional phase on salmonid potential downstream reaches with locally higher ecological value will represent a temporary moderate to significant water quality impact with potential for elevated suspended solids concentrations and potential for short-term sediment deposition.

The operational impact of the proposed watercourse realignments/diversions will be very localised to morphology changes in the stream channel during large floods and which will stabilise over time. The potential impact is rated to be a locally minor impact which can be further minimised through engineering design (trapezoidal channel with side slopes 1 in 2) of the channel and transitions including provision of culvert wing-walls and armoured bed and channel banks at such transitions. The significant realignment works to the Tonabrocky Stream represent a permanent moderate impact as the realignment diverts the stream channel in a relatively straight artificial channel that has relatively steep channel banks.

The drainage design has also identified that a number of minor drains/watercourses are intercepted by the proposed road development, principally in the western section of the proposed road development (i.e. west of the River Corrib). A number of the smaller field and roadside drains can, from a hydraulic and fisheries perspective, be truncated and the upstream portion diverted either to another existing drain close by or be connected into the road embankment drainage.

The relatively high density of the proposed road drainage outfalls will result in a very minor potential for significant diversion of drainage and recharge waters between neighbouring sub-catchments. The disturbance of field drainage systems represents a direct impact to the existing drainage regime. Following the detailed design this impact is considered to represent a residual slight to imperceptible and permanent in nature impact on the hydrology of adjacent wetland features, conservation areas and flood risk areas.

11.5.3.3 Flow Regime Impact from Drainage Outfalls

The drainage outfall discharges to surface watercourses represent point discharges. Therefore, locally, the discharges will change the flow rate, the flow depth and velocity in the receiving watercourse and generally cause an increase locally, but elsewhere it may cause a reduction. In general, there is not a significant transfer of catchment runoff between streams and tributaries and therefore the water balance is not negatively impacted. It is found that the impact to existing watercourses from the road storm discharge varies depending on the size of the natural catchment. The greater the natural catchment the lower the potential impact as the channels are better developed. Another reason for lower potential flow impact on the larger catchments is due to the smaller stormwater discharge volume relative to the natural stream and river volumes. The potential increase in the ambient water levels arising in larger catchment sizes therefore is reduced.

The impact to flood regime in the receiving watercourse represents potentially the more significant impact as road drainage can increase the rate and volume of flood runoff and cause potential flooding and scouring of the receiving watercourse locally. The design includes the provision of attenuation ponds and flow control to restrict the outfall discharge to a more natural greenfield flood runoff rate, thereby avoiding potential significant impacts to channel morphology and flow regime at the local scale. The potential impact magnitude is presented in **Table 11.29**.

Table 11.29: Impact Assessment of Storm Drainage on Receiving Waters in Respect to flow regime and Morphological Changes

Network Drainage Ref. No.	Outfall Chainage	Total Road Drainage Area (ha)	Receiving Water Catchment Area (ha)	Channel / Lake Capacity	Greenfield Mean Annual Maximum Flood Runoff Rate in Receiving Stream (m^3/s)	Potential Impact
S1	0+000	2.05	147	Narrow vegetated channel Low flood capacity constricted downstream by R336 culvert	1.132	Slight Local
S2	0+625	0.55	79	Narrow vegetated channel Low flood capacity	0.608	Slight Local
S3	0+900	2.31	32	Narrow vegetated channel Low flood capacity	0.246	Slight Local
S4A	1+550	0.96	5	Narrow vegetated channel Poor channel capacity	0.019	Slight Local
S5A	2+750	2.45	50	Narrow vegetated channel Low flood capacity	0.19	Slight Local
S7A	3+000	0.30	6	Narrow vegetated channel Low flood capacity	0.02	Slight Local
S7B	3+950	2.94	582	moderate capacity wide flat gravelly base	2.150	Slight Local
S8	4+000	0.42	85	moderate capacity channel	0.314	Slight Local
S9	4+150	1.75	494	moderate capacity wide flat gravelly base	1.828	Slight Local
S10	4+850	2.19	190	moderate capacity channel narrow	0.703	Slight Local
S11	6+000	2.02	16	Discharge to Storm Sewer – limited capacity	0.103	Slight Local

Network Drainage Ref. No.	Outfall Chainage	Total Road Drainage Area (ha)	Receiving Water Catchment Area (ha)	Channel / Lake Capacity	Greenfield Mean Annual Maximum Flood Runoff Rate in Receiving Stream (m^3/s)	Potential Impact
S12	6+850	3.15	177	Narrow vegetated channel Low flood capacity culverted downstream	1.140	Slight Local
S13	7+350	0.91	32	Narrow vegetated channel Low flood capacity culverted downstream	0.206	Slight Local
S14A	8+300	5.66	14	Moderate channel capacity discharge to large storm culvert pipe and culvert under N59	0.090	Slight Local
S14B	8+550	0.85	26	Moderate to Low channel capacity	0.167	Slight Local
S15	east of N59 link	1.89	5	Good capacity channel	0.032	Slight Local
S18A	9+250	1.75	313,600	Good capacity channel	265.0	Imperceptible
S18B	9+425	2.27	313,600	Good capacity channel	265.0	Imperceptible
S21A	12+250	3.31	225	Good capacity as channel part of the permanent Lake area	0.621	Imperceptible
S36A	3+380	0.24	10	Minor Stream at Aille that is diverted into PED drain which discharges to Bearna Stream	0.064	Slight Local
S36B	3+380	0.10	14	Boundary Ditch	0.090	Slight Local
S31A	7+230	0.09	32	Narrow vegetated channel Low flood capacity culverted downstream	0.206	Slight Local
S31B	7+230	0.15	32	Narrow vegetated channel Low flood capacity culverted downstream	0.206	Slight Local

Network Drainage Ref. No.	Outfall Chainage	Total Road Drainage Area (ha)	Receiving Water Catchment Area (ha)	Channel / Lake Capacity	Greenfield Mean Annual Maximum Flood Runoff Rate in Receiving Stream (m^3/s)	Potential Impact
S44	9+150	0	10	Good capacity channel	0.064	Slight Local

11.5.4 Potential Impact to Water Quality

During the operational phase, the storm outfalls outlined in **Section 11.4.1.3** have a potential to adversely impact water quality in the receiving watercourse and groundwater from routine contaminants that are contained in road drainage waters. The water quality and ecological status of the receiving waters are also potentially threatened by contamination arising from large liquid spillages as a result of an accident on the proposed road development. These impacts are assessed by using the guidelines provided in the appropriate TII publications document DN-DNG-03065 (HD45) Road Drainage and the Water Environment. The outfalls discharging via infiltration basins to groundwater are assessed in **Chapter 10, Hydrogeology**. A summary of the paved area contributing from the proposed road drainage outfalls to the receiving surface watercourses are presented in **Table 11.30**.

The surface water storm outfalls also have the potential to impact the general flow and morphological regime of a receiving watercourse by increasing the volume and rate of runoff during storm events. The morphology of the stream is significantly influenced by ambient flow and flooding conditions in the stream. The potential increase in flow volume to the stream arises from an increased impervious area from the proposed road pavement area, the provision of road and embankment drainage with a direct pathway via the road drainage system to the receiving watercourse and potential interception of groundwater and diversion of drainage waters that would not otherwise have reached the outfall point. The hard-paved areas and the road drainage system reduces the time of concentration for rainwater to arrive at the outfall and thus increases the rate of runoff over the natural greenfield condition.

It is anticipated that the proposed road development will remove traffic from the existing road network which will provide some benefit as most these existing roads do not have sustainable urban drainage systems to protect surface and groundwater bodies from drainage water quality impacts.

Most of the surface watercourses being outfalled to by the proposed road drainage networks are only of high local value, but do eventually discharge to the European sites of the Lough Corrib cSAC and the Galway Bay Complex cSAC and Inner Galway Bay SPA. The N59 Link Road North outfall S15 eventually discharges to Lough Corrib cSAC and Lough Corrib SPA via an open drain at Dangan. Such watercourses provide a good buffer for attenuation and provide natural wetland treatment before reaching any of the European sites. Outfalls S18A and S18B discharge directly to the River Corrib channel, which is of high sensitivity being a salmonid river, European designated site and major public water supply source (Terryland Galway City water supply intake). All of the receiving watercourses have local higher attribute value further downstream in their lower reaches and all the outfalls to the Bearna, Knocknacarra and River Corrib Systems eventually discharge into the Galway Bay Complex cSAC and Inner Galway Bay SPA. Waters in the Sruthán na Libeirtí and the Trusky Stream at Bearna have the potential after mixing with the coastal waters to reach the tidal waters of the Galway Bay Complex cSAC and Inner Galway Bay SPA.

Outfalls S18A and S18B are located on the banks of River Corrib bank edge and represent very limited disturbance with the construction works to be carried out from the banks. Therefore water quality risks are significantly reduced. Construction works for outfalls S14A, S14B and S15 located at Dangan/Bushypark on its western bank discharge to the River Corrib via drainage ditches over distances of c.300 to 800m. These ditches provide an excellent wetland and settlement buffer to protect the River Corrib from construction runoff. Notwithstanding this buffer, the construction erosion and Sediment, Erosion and Pollution Control Plan, in the CEMP contained in **Appendix A.7.5** will apply to these watercourses designed to minimise the direct construction runoff to watercourses and minimise disturbance of sediment from in-stream and river bank works.

Table 11.30: Summary of Proposed Road Drainage Outfalls to Receiving Watercourses

Drainage Reference	Approx. Ch. Of Outfall	Road Section Ch. Start – Ch. End	Total Impervious Road Area (ha)	Receiving Catchment Area (km^2)	Mean Flow (cumec)	95% Low Flow (cumec)	Catchment	Comment and Fisheries Value
S1	0+000	0+000 – 0+700	1.29	1.47	0.03	0.05	Sruthán na Libeirtí	Local Lower at Site and downstream
S2	0+625	0+700 – 1+000	0.38	0.79	0.02	0.002	Sruthán na Libeirtí	Local Lower at Site and downstream
S3	0+900	1+000 – 1+475	1.28	0.32	0.01	0.0006	Sruthán na Libeirtí	Local Lower at Site and downstream
S4A	1+550	1+475 – 1+900	0.62	0.05	0.001	0.0001	Trusky Tributary	Minor drain Local Higher downstream
S4B	1+560	L-580 – 680	0.07	0.05	0.001	0.0001	Trusky Tributary	Minor drain Local Higher downstream
S5A	2+750	1+900 – 2+850	1.53	0.50	0.011	0.0010	Trusky	Small Stream Local Higher downstream
S5B	2+750	L- 000 – 300	0.14	0.07	0.0012	010001	Trusky Ditch	Minor drain Local Higher downstream
S7A	3+000	2+850 – 3+050	0.24	0.06	0.001	0.0001	Bearna Tributary	Minor drain Local Higher downstream
S7B	3+950	3+050 – 3+900	1.07	5.82	0.129	0.0116	Bearna	Small Stream Local Higher downstream
S8	4+000	3+910 – 4+125	0.26	0.85	0.019	0.0017	Bearna Tributary	Minor drain Local Higher downstream
S9	4+150	4+125 – 4+900	1.19	4.94	0.110	0.0099	Bearna	Bearna Stream Local Higher downstream

Drainage Reference	Approx. Ch. Of Outfall	Road Section Ch. Start – Ch. End	Total Impervious Road Area (ha)	Receiving Catchment Area (km^2)	Mean Flow (cumec)	95% Low Flow (cumec)	Catchment	Comment and Fisheries Value
S10	4+850	4+900 – 5+640	1.22	1.90	0.042	0.0038	Bearna Tributary. Tonabrocky	Small Hill side stream Local Higher downstream
S12	6+850	6+325 – 7+300	2.45	1.77	0.039	0.0035	Knocknacarra Tributary	Minor drain Local Higher downstream
S13	7+350	7+300 – 7+525	0.63	0.32	0.007	0.0006	Knocknacarra Tributary	Minor drain Local Higher downstream
S14A	8+300	7+525 – 8+250	2.20	0.14	0.003	0.0003	Corrib Tributary	Minor hillside drain Corrib SAC downstream
S14B	8+550	8+250 – 8+525	0.65	0.26	0.006	0.0005	Corrib Tributary	Minor hillside drain Corrib SAC downstream
S15	East of N59 Link	0 – 625 N59 Link	0.73	0.050	0.001	0.0001	Local Ditch to Corrib	Minor drain Lough Corrib cSAC
S18A	9+250	8+525 – 9+250	1.58	3136	82.000	14.000	Corrib River West Bank	Extremely Important Lough Corrib cSAC
S18B	9+425	9+250 – 10+150	1.95	3136	82.000	14.000	Corrib River East Bank	Extremely Important Lough Corrib cSAC
S21A	12+250	11+850 – 12+450	1.36	< 0.05	< 0.001	< 0.0001	Ballindooley Lough Tributary	Minor drain Local Higher downstream
S36A	3+380	3+350	0.17	0.10	0.0022	0.0002	Bearna Stream Tributary	Minor drain (Tributary of Bearna stream) Local Higher downstream
S36B	3+380	3+350	0.08	0.14	0.0028	0.0003	Trusky Stream Tributary	Minor drain (Tributary of Trusky stream) Local Higher downstream
S31A	7+230	7+250	0.06	0.26	0.006	0.0005	Knocknacarra Tributary	Minor drain (Tributary of Rahoon stream) Local Higher downstream

Drainage Reference	Approx. Ch. Of Outfall	Road Section Ch. Start – Ch. End	Total Impervious Road Area (ha)	Receiving Catchment Area (km^2)	Mean Flow (cumec)	95% Low Flow (cumec)	Catchment	Comment and Fisheries Value
S31B	7+230	7+250	0.12	0.27	0.006	0.0005	Knocknacarra Tributary	Minor drain (Tributary of Rahoon stream) Local Higher downstream
S44	9+150	N/A	N/A	0.17	0.003	0.0003	River Corrib Tributary	Minor drain Lough Corrib cSAC

11.5.4.1 Accidental Spillages

During the operational phase of the proposed road development, the risk of pollution to both surface and groundwater resulting from accidental spillage is an issue to be considered. Trying to predict the occurrence of a spill with any degree of certainty is difficult. The risk is influenced by the type of roadway, length of road, the traffic volume, and proportion and type of heavy goods vehicles (HGV's), design speed and visibility. A spillage risk assessment of the proposed road development has been carried out in accordance with the TII publications document DN-DNG-03065 (HD45) – see **Table 11.31**.

The spillage assessment shows the proposed road development will have a very low magnitude of risk for individual outfalls or grouped catchment outfalls, and as such specific mitigation measures to lower this risk are not required under the TII publications road design standards.

The overall combined probability of a serious HGV spillage entering a watercourse from the proposed road development is low at 0.09%. This spillage risk analysis was based on the medium growth AADT Traffic figures, presented in **Chapter 6, Traffic Assessment and Route Cross-Section**, which indicate that HGV numbers are only 3 to 6% of the AADT number.

A similar assessment was carried out for the proposed outfalls to groundwater via infiltration basins and is presented in **Table 11.32** and similarly show very low probabilities.

Notwithstanding the very low spillage risk for this proposed road development, all storm outfalls will include pollution control facilities at their outfalls. All of the mainline drainage network outflows will pass through a suitably sized oil and petrol interceptor and then through a constructed wetland with a permanent pool followed by an attenuation pond or infiltration basin, depending on the design prior to discharging through its outfall. A penstock or similar online control restriction will be installed upstream of the petrol interceptor. In the event of a serious spill these controls can be put in place to block the outflow of contaminants allowing time for clean up to take place.

Table 11.31: Serious Spillage Pollution Risk Assessment at Proposed Outfalls to Surface Watercourses

Drainage Reference	Approx. Chainage	Watercourse	Outfall Risk (%)	Combined Risk (%)
S1	0+000 - 0+700	Sruthán na Libeirtí	0.0066	
S2	0+700 - 1+000	Sruthán na Libeirtí	0.0005	
S3	1+000 - 1+475	Sruthán na Libeirtí	0.0025	0.0096
S4A	1+475 - 1+900	Trusky Tributary	0.0023	
S4B	Link Road 0+580 - 0+680	Trusky Tributary	0.0001	
S5A	1+900 - 2+850	Trusky Stream	0.0068	

Drainage Reference	Approx. Chainage	Watercourse	Outfall Risk (%)	Combined Risk (%)
S5B	Link Road	Ditch Trusky Tributary	0.0001	
S7A	2+850 - 3+050	Ditch Trusky Tributary	0.0004	0.0097
S7B	3+050 - 3+910	Bearna	0.0015	
S8	3+910 - 4+125	Bearna	0.0004	
S9	4+125 - 4+900	Bearna	0.0029	
S10	4+900 - 5+640	Bearna Tributary.	0.0028	0.0080
S12	6+325 - 7+300	Knocknacarra Tributary	0.0031	
S13	7+300 - 7+525	Knocknacarra Tributary	0.0008	0.0073
S14A	7+525 - 8+250	Corrib Tributary	0.0062	
S14B	8+250 - 8+525	Corrib Tributary	0.0029	
S15	0 - 625 N59 link	Existing Ditch to Corrib	0.0062	
S18A	8+525 - 9+250	Corrib River West Bank	0.0054	
S18B	9+250 - 10+150	Corrib River East Bank	0.0067	0.042
S21A	Sliproads and N84 interchange	Ballindooley Lough	0.0138	
S36A	Aille Road North	Bearna Stream Tributary	0.0000	
S36B	Aille Road South	Trusky Stream Tributary	0.0000	
S31A	Letteragh Road	Knocknacarra Tributary	0.0000	
S31B	Letteragh Road	Knocknacarra Tributary	0.0000	
S44	9+150	Corrib Tributary	0.0000	

Table 11.32: Serious Spillage Pollution Risk Assessment at Proposed Outfalls to Groundwater Infiltration

Drainage Network Ref. No.	Approx. Chainage	Outfall Risk (%)
S19A	10+150 to 10+730	0.00286
S19B	10+730 to 11+150	0.00207
S20	11+414 to 12+017	0.00320
S21B	12+017 to 13+700	0.01361
S22A	13+700 to 13+920	0.01557
S22B	13+920 to 14580	0.0038
S22C2	13+650 to 14+160	0.00045
S22E	N83 Tuam Road Junction	0.00006
S40	10+450	0.0000

11.5.4.2 Routine Road Runoff

Research has found that a broad band of potential pollutants are associated with routine runoff from road schemes arising from road traffic and road maintenance. These contaminants are generally associated with the particulate phase and are principally heavy metals, hydrocarbons and suspended solids and de-icing agents (salt and grit) and to a lesser extent nutrients, organics and faecal contamination. In terms of the potential impact to receiving watercourses research has found the first flush runoff (10 to 15mm rainfall runoff following an extended dry period) can produce elevated concentrations locally in the receiving waters. The impact of contaminants within routine road runoff depends on the loading (associated with traffic numbers) and the available dilution in the receiving watercourse.

The high density of outfall discharge points along the mainline of the proposed road development, disperses and reduces the potential pollutant point load from the proposed road drainage system. The design traffic volume in conjunction with the relatively small contributing road areas will not give rise to any potential significant hydraulic or pollutant loads on the receiving waters. The potential impact of routine runoff in the absence of storm drainage pollutant removal represents a localised impact on water quality of the receiving environment. The overall loading of heavy metals, sediments, hydrocarbons and other waste products on the receiving waters will be significantly reduced through the provision of various drainage design elements such as, petrol and oils interceptors, filter drains, grassed surface water channels, wetlands, infiltration area and storm attenuation ponds upstream of the outfalls designed to capture and treat the first flush rainfall runoff events.

TII publications document DN-DNG-03065 (HD45) gives guidance and assessment tools for the impact of road projects on the water environment, including the effects of runoff on surface waters. The Highways Agency Water Risk Assessment Tool (HAWRAT) is the tool used to assess the effects of road runoff on surface water quality and uses toxicity thresholds based on UK field research programmes which are consistent with the requirements of the Water Framework Directive (WFD) and appropriate for assessment of National Road Schemes in Ireland. The UK research programme has shown that pollution impacts from routine runoff on receiving waters are broadly correlated with Annual Average Daily Traffic (AADT) numbers.

A HAWRAT assessment has been carried out for all proposed mainline drainage outfalls directly discharging to surface watercourses along the proposed road development, including realigned and upgraded link roads and junctions, see **Table 11.33** below. The HAWRAT assessment tool uses the AADT category of 10,000 to 40,000 in the assessment process which is appropriate for the Design Year AADT numbers. Further to the west, as ADDT numbers reduce, this category is likely to be precautionary in terms of its water quality predictions as the ADDT numbers are much closer to 10,000 than 40,000. Anticipated traffic volumes on each section of the proposed road development are detailed in **Chapter 6, Traffic Assessment and Route Cross Section**.

It is also important to note that the HAWRAT assessment presented here is based on direct discharges to watercourses in the absence of proposed drainage design measures, that include petrol interceptors, water quality treatment ponds and wetlands and storm attenuation ponds, and therefore the predictions are worst case not including any treatment performance which have been designed to achieve well in excess of 60% reduction in suspended sediments and associated heavy metal contamination. The HAWRAT analysis was carried out on all of the proposed outfalls in the absence of proposed water quality and attenuation measures and the required level of treatment quantified, refer to **Table 11.33** below.

In cases where the road drainage outfall discharges to a drainage ditch with very limited drainage catchment, resulting in potentially dry / stagnant conditions during low flows, the local HAWRAT assessment will produce a FAIL result, as there is no dilution available for solutes nor flow velocities to disperse sediment away from the outfall. These failures in the HAWRAT analysis are not considered to represent an impact as such minor ditches are only serving as conduits to the larger stream and river channels. In these cases, the potential impact on watercourses is also assessed further downstream where it joins the larger stream channel, refer to outfall locations on **Figures 11.6.101** to **11.6.115**.

In general, HAWRAT is considered to provide a precautionary means to assess those proposed road outfall discharges in respect to soluble and sediment-bound pollutants. The screening parameters are sediment and the dissolved heavy metals of zinc and copper concentrations. These represent the primary waste constituents in the road drainage discharges and used as screening parameters for other pollutant substances such as de-icing agents of salt and grit, hydrocarbons, Cadmium, Pyrene, PAHs, nutrients and organics. The required treatment performance in terms of percentage reduction of soluble and sediment contaminants is also presented in **Table 11.33**.

Table 11.33: Results of the HAWRAT Road Outfall Water Quality Assessment of Receiving Surface Waters

Outfall No. Refer to Figures 11.6.101 to 11.6.115	**Water Hardness (mg/l $CaCO_3$)**	**Dissolved Copper (ug/l)**	**Dissolved Zinc (ug/l)**	**Sediment Deposition Index**	**Comment**
S1	Low < 50	0.31	0.93	174	Pass Solubles, Fail Sediment (Settlement required 43%)
S2	Low < 50	0.20	0.62	84	Pass Solubles, Pass Sediment accumulates but not extensive
S3	Low < 50	1.07	3.27	248	Fail Solubles, Fail Sediment (Required Treatment Solubles 30% reduction Settlement 76%
S4A	Low < 50	2.01	6.27	250	Fail Solubles, Fail Sediment

Outfall No. Refer to Figures 11.6.101 to 11.6.115	**Water Hardness (mg/l $CaCO_3$)**	**Dissolved Copper (ug/l)**	**Dissolved Zinc (ug/l)**	**Sediment Deposition Index**	**Comment**
					(Required Treatment 61% settlement and 56% soluble reduction)
S5A	Low < 50	0.87	2.65	299	Fail Solubles, Fail Sediment (Required Treatment 67% settlement and 25% soluble reduction)
S7A	Low < 50	1.39	4.27	122	Fail Solubles, Fail Sediment (Required Treatment 18% settlement and 44% soluble reduction)
S7B	Low < 50	0.09	0.27	41	Pass Solubles, Pass Sediment
S8	Low < 50	0.16	0.50	44	Pass Solubles, Pass Sediment
S9	Low < 50	0.13	0.40	50	Pass Solubles, Pass Sediment
S10	Low < 50	0.31	0.96	87	Pass Solubles, Pass Sediment
S12	Low < 50	0.60	1.87	191	Pass Solubles, Fail Sediment (Required Treatment 48% settlement)
S13	Low < 50	0.82	2.55	178	Fail Solubles, Fail Sediment (Required Treatment 44% settlement and 3% soluble reduction)
S14A	Med 50 – 200	2.39	7.38	725	Fail Solubles, Fail Sediment (Required Treatment 87% settlement and 35% solubles reduction)
S14B	Med 50 – 200	1.11	3.46	365	Fail Solubles, Fail Sediment (Required Treatment 49% settlement and 10% solubles reduction)

Outfall No. **Refer to Figures 11.6.101 to 11.6.115**	**Water Hardness (mg/l $CaCO_3$)**	**Dissolved Copper (ug/l)**	**Dissolved Zinc (ug/l)**	**Sediment Deposition Index**	**Comment**
S15	Med 50 – 200	2.42	7.49	175	Fail Solubles, Fail Sediment (Required Treatment 61% settlement and 25% solubles reduction)
S18a	Med 50 – 200	<0.00	<0.00	1	Pass Solubles, Pass Sediment
S18b	Med 50 – 200	<0. 00	<0.00	2	Pass Solubles, Pass Sediment

A HAWRAT water quality toxicity analysis of the proposed road development discharges to the River Corrib was also carried out modelling the soluble heavy metal pollutants of copper and zinc from combined outfall sources. In this analysis the 95 percentile low river flow was specified, an AADT Class of >10,000 and < 40,000 and the combined load of all five outfalls having a total road impervious area of 7.08ha and a permeable (Grassed) area of 5.43ha. The annual rainfall catchment was taken as 1250mm, the base flow index as 0.5 the water hardness as medium (50 to 200 CaCO3 mg/l). A cumulated load from all of the outfall discharges (S14A, S14B, S15, S18A and S18B, ref **Figures 11.6.101** and **11.6.114**) was also specified in the HAWRAT assessment water quality toxicity analysis so as to include for the combined effects on the Dangan reach section of the River Corrib. Note that the outfall from the proposed NUIG pitches S44 was not assessed in this combination as this catchment is not a road, therefore routine road runoff water quality characteristics from traffic at this location is not applicable. This combined load simulation showed no discernible acute or chronic impacts on the water quality of River Corrib due to the high dilutions rates available in the River Corrib. The event statistics for the untreated effluent in the drainage runoff give the following event statistics, refer to **Tables 11.34** and **11.35**. These loadings are used as the mean concentration in the two-dimensional modelling of the River Corrib receiving waters presented latter in this section.

Table 11.34: Event Statistics for soluble heavy metal pollutants in untreated Road Drainage Runoff

	Dissolved Copper Cu (µg/l)	**Dissolved Zinc Zn (µg/l)**
Mean	24.00	67.53
90%	45.95	144.85
95%	57.54	191.09
99%	90.93	346.16

Table 11.35: Event Statistics for soluble heavy metal pollutants in River Corrib at 95% low flow

	Dissolved Copper Cu (µg/l)	Dissolved Zinc Zn (µg/l)
Mean	0.00	0.01
90%	0.00	0.01
95%	0.01	0.02
99%	0.03	0.08

The event statistics for this grouped discharge give a mean event concentration in the River Corrib of that is negligible (<0.00 (µg/l)) for copper and (<0.01 (µg/l)) for zinc and 99-percentile event statistics of 0.03 (µg/l) dissolved copper and 0.08 (µg/l) dissolved zinc which are considered to represent only trace concentrations and well below the maximum allowable concentrations of 30 and 100 µg/l as set out in the Surface Water Regulations. In the HAWRAT manual the runoff specific thresholds for short term exposure of organisms gives the following short-term exposure threshold values for dissolved copper and zinc.

Table 11.36: Maximum Short-term exposure threshold limits for dissolved copper and zinc (WRc 2007)

Exposure Duration	Copper (µg/l)	Zinc (µg/l)		
		Harness		
		Low (< 50mg/l CaCO3)	Medium (50 to 200 mg/l CaCO3)	High (>200mg/l CaCO3)
24 hour	21	60	92	385
6 hour	42	120	184	770

This assessment clearly shows that the dilution available in the River Corrib even at 95-percentile low flow conditions ensures that the potential toxicity impact from road runoff contaminants on this salmonid river will be negligible and well below allowable levels for dissolved copper and zinc set out in the Salmonid Waters Directive and in the Surface Waters Regulations and also well below the recommended short-term exposure thresholds presented in **Table 11.36** above.

It should be noted that the above assessment is carried out in the absence of proposed road drainage water quality and attenuation treatment and therefore the potential impact will be considerably lower after the designed treatment.

The provision of first flush treatment in a wetland system and the storage in the attenuation pond provides residence time for the sediment to settle out before being discharged to the watercourse. This storage also reduces the outfall discharge rate with the contaminated first flush event being stored and released gradually.

This grouped assessment was also carried out on Sruthán na Libeirtí, the Knocknacarra, Bearna and Trusky Streams and were found to satisfy the HAWRAT water quality assessment in the downstream fishery reaches. The impact on water chemistry downstream in the coastal waters will be negligible due to the significant mixing available in the downstream reaches of the watercourses and within the tidally flushed estuarine reaches.

For the various individual outfalls discharging to small drains and streams with limited upstream catchment, it is found that the majority of these outfalls fail the HAWRAT assessment (in absence of pollution control measures), simply because there is negligible flow for dilution during 95-percentile low flow design conditions. At these locations, these failures are not considered significant as locally these smaller drains are not fishery sensitive and further downstream in the receiving streams the flow rate and contributing catchment area increases which lessens any potential impact.

The proposed storm drainage design for all proposed new surface water outfalls discharging to watercourses includes a spillage containment area ($25m^3$), a petrol and oil interceptor, a surface flow (SF) wetland with a permanent pond depth of 0.6m (to take first flush volume 15mm) and an attenuation pond (typically having a storage volume of a further 70mm rainfall over the paved area). Such facilities will achieve a long hydraulic residence time for first flush pollutant events ensuring good settlement performance. Flood attenuation will not be provided at the direct outfalls to the River Corrib S18A and S18B as attenuation of the proposed road storm flow is not warranted given the immense scale of the River Corrib catchment and capacity of the channel relative to the proposed road drainage direct discharges at S18A and S18B. The other pollution control elements including spillage containment, wetland first flush treatment and petrol and oil interceptors will be provided to achieve storm water treatment and accidental spillage protection for these outfalls.

The expected performance of the designed pollution control measures is expected to achieve in excess of 60% settlement performance of particulate matter but for soluble substances unlikely to achieve above 30% reduction and lower performances during the non-growing season, refer to **Table 11.37** below. The design ensures no significant water quality impact on receiving designated waters of the Lough Corrib cSAC and Lough Corrib SPA and the downstream Galway Bay Complex cSAC and Inner Galway Bay SPA.

Table 11.37: Expected Pollutant Removal Performance of Vegetated systems extracted from TII DN-DNG-03063

Runoff Constituent	**Stormwater treatment system Performance**					
	Swales	**Infiltration Basins**	**SF Wetlands**	**SSF ** Wetlands**	**Detention / Retention Ponds**	**Sedimentation Ponds**
Sus Solids & associated heavy metals	Good	Good	Good	Good	Moderate	Good
Heavy Metals in solution *	Moderate - Good	Moderate - Good	Moderate - Good	Good	Poor	Poor - moderate
Oil and grease	Good	Moderate - Good	Good	Good	Moderate	Moderate
Nutrients	Poor	Poor	Moderate - Good	Good	Poor	Poor - moderate

Notes:

Poor represents < 30% removal efficiencies, Moderate represents 30 to 60% removal efficiency and Good represents > 60% removal efficiency

* applicable to Growing Season

** very limited operational life of SSF Wetlands due to clogging of substratum

In general, the most likely impact of untreated road runoff from the proposed road development is the increased total suspended solids loading to receiving waters and associated trace amounts of heavy metals (Cu, Zn) and hydrocarbons. At all proposed surface drainage outfalls, water quality treatment of the sediment load is provided for, which will reduce local impacts from sediment deposition accumulation and potential toxicity levels in the stream/drain channel immediately close to the outfall.

The two tunnel sections of the proposed road development do not receive direct surface water runoff, however small volumes of water could potentially be carried into the tunnel on tyres and bodies of wet vehicles. These volumes will be picked up by the internal sealed tunnel drainage and pumped to the foul sewer. This volume for treatment is miniscule (fraction of a percent) in comparison to the overall sewage and combined storm volume treated at the Mutton Island Plant and discharged to the Galway Bay via the Mutton Island marine outfall and therefore will have no perceptible effect of treatment performance of the Mutton Island Treatment Plant and the Galway Bay receiving waters.

The Water Quality Impact Assessment is presented in **Table 11.38** below:

Table 11.38: Water Quality Impact Assessment

Network Drainage Ref. No.	Outfall Chainage	Dilution Characteristics	Receiving Water Details	Water Quality Impact
S1	0+000	Low summer dilution available	Sruthán na Libeirtí	Slight Permanent Local Slight downstream
S2	0+625	Low summer dilution available	Sruthán na Libeirtí	Slight Permanent Local Slight downstream
S3	0+900	Low summer dilution available	Sruthán na Libeirtí	Moderate Permanent Local Slight downstream
S4A	1+550	Very Low summer dilution available	Trusky Tributary	Moderate Permanent Local Slight downstream
S5A	2+750	Low summer dilution available	Trusky Tributary	Slight Permanent Local Slight downstream
S7A	3+950	Very Low summer dilution available	Bearna Tributary	Moderate Permanent Local Slight downstream
S7B	3+950	Moderate summer dilution available	Bearna Stream	Slight Permanent Local Slight downstream
S8	4+000	Low summer dilution available	Bearna Tributary	Slight Permanent Local Slight downstream
S9	4+150	Moderate summer dilution available	Bearna Stream	Slight Permanent Local Slight downstream
S10	4+850	Low summer dilution available	Bearna Tributary Tonabrocky	Slight Permanent Local Slight downstream
S11	6+000	Very low summer low flow dilution available	Storm Sewer to Knocknacarra	Slight Permanent Local Slight downstream
S12	6+850	Low summer low flow dilution available	Knocknacarra Tributary	Moderate Permanent Local Slight downstream
S13	7+350	Very low summer low flow dilution available	Knocknacarra Tributary	Slight Permanent Local Slight downstream
S14A	8+300	Very low summer low flow dilution available	Minor River Corrib Stream	Moderate Permanent Local and imperceptible in downstream receiving Corrib waters
S14B	8+550	Very low summer low flow dilution	Minor River Corrib Stream	Slight Permanent Local and imperceptible in downstream receiving Corrib waters
S15	east of N59 link	Very Low summer dilution	Local drainage Ditch to River Corrib	Moderate Permanent Local and imperceptible in downstream receiving Corrib waters
S18A	9+250	Very High Summer low flow dilution	River Corrib	Slight Permanent Local

Network Drainage Ref. No.	Outfall Chainage	Dilution Characteristics	Receiving Water Details	Water Quality Impact
S18B	9+425	Very High Summer low flow dilution	River Corrib	Slight Permanent Local
S21A	12+250	Low Summer dilution Eventually drains to groundwater	Ballindooley Lough	Moderate Permanent Local

Detailed Assessment of River Corrib

River Corrib Channel

Two-dimensional transport and dispersion modelling of the outfall discharges in the River Corrib was carried out so as to assess the local impact effects of the plume near the inflow points and downstream, where full mixing with the receiving flow will not have fully occurred. Simulations were carried out modelling the two principal soluble heavy metal pollutants in the drainage effluent, namely copper and zinc and included the proposed first flush stormwater treatment in the wetland and attenuation ponds, which are designed to capture the first flush event of 15mm rainfall runoff and release slowly back to the River Corrib system so that a high percentage of the sediment is removed through settlement. Low flow conditions were modelled in the River Corrib with the river discharge rate set at the 95-percentile low flow of 14cumec (note median river flow is 82cumec) and the downstream water level upstream of the Salmon Weir barrage set at 5.7m OD (median 5.9mOD).

The event mean runoff concentrations from the HAWRAT model was specified as the storm effluent concentration at the outfalls of 24 µg/l Cu and 67.53 µg/l Zn. The simulation was run for combined outfall discharges on the western side of the River Corrib (outfalls 14A, 14B, 15 and 18A). An independent simulation for outfall S18B on the eastern bank of the River Corrib was also run and results combined with the western outfall simulations to predict the overall impact of the proposed road drainage discharge on the River Corrib. Note that the outfall from the proposed NUIG pitches S44 was not assessed as part of this analysis as this catchment is not a road, therefore routine road runoff water quality characteristics from traffic at this location is not applicable.

The drainage discharge plume in the River Corrib migrates with the flowing river downstream towards Galway Bay and therefore exposure duration is limited to hours as opposed to days. The maximum predicted concentrations throughout the model domain are presented below in **Plates 11.2** to **11.7** which show that the plume hugs the near bank side of the river for quite a distance downstream before fully mixing across the river channel. The simulations show that during the River Corrib low flow conditions the stormwater plume does not enter via the small channel east of Jordan’s Island and therefore has very limited effect on the Terryland Galway City water supply intake. It is also noted that the plume does not travel up in the Coolagh Lakes system under these conditions. The large dispersion provided by the River Corrib result in rapid dilution and low trace level pollutant concentrations in the receiving water. The potential impacts on water quality in Lough Corrib cSAC and Lough Corrib SPA arising from the plume are imperceptible.

The analysis shows that the potential soluble toxicity levels of copper and zinc in the receiving waters are negligible in terms of the threshold levels for 24-hour and 6-hour exposure periods. The available dilution in the River Corrib at low flow conditions is still very large and therefore the combined discharge from the various outfalls to the reach is very well diluted and does not impact the water quality or quantity in the receiving waters.

These simulations predict very low far-field concentrations of heavy metal pollutants under the River Corrib 95-percentile low flows of less than 0.05µg/l dissolved copper and less than 0.1µg/l dissolved zinc in the river channel near Jordan's Island. More elevated concentrations are predicted close to the outfalls of S18A and S18B on both River Corrib banks with predicted concentrations with a maximum local concentration of 1.75µg/l dissolved copper and 4.92µg/l dissolved zinc. These locally elevated concentrations are well below any potential exposure threshold levels for heavy metals (refer to **Table 11.36**) and easily satisfy the surface water and Salmonid Waters Regulations. At mean river flow the concentration both locally at the outfall and fully mixed downstream are significantly lower at almost six times lower than the River Corrib low-flow scenarios described above.

The potential impact of de-icing agents such as sodium chloride on the receiving water quality of the River Corrib will not result in a water quality impact as the dilution is large and particularly so during winter months, which is the high flow period with river flows generally above the median flow which dilutes and rapidly transports the salt load through the lower reaches of the River Corrib out to sea where they are imperceptible and have no effect.

The water quality impact of the proposed stormwater discharge on the River Corrib, given its high dilution and assimilative capacity, represents only a slight impact immediately local to the outfalls. The high water quality status of the River Corrib will not be affected by the proposed road development and its road drainage discharges.

The dispersion analyses show only trace pollutant concentrations reaching Jordan's Island channel and the Terryland Galway City water supply intake from the proposed road drainage discharges and can be concluded that the first flush impact of road drainage runoff on the water quality of the intake flow will be imperceptible.

Plate 11.2: Maximum Dissolved Copper Concentrations for First Flush Storm Water Event and 95% River Corrib Low Flow for Outfall 18B at Menlough

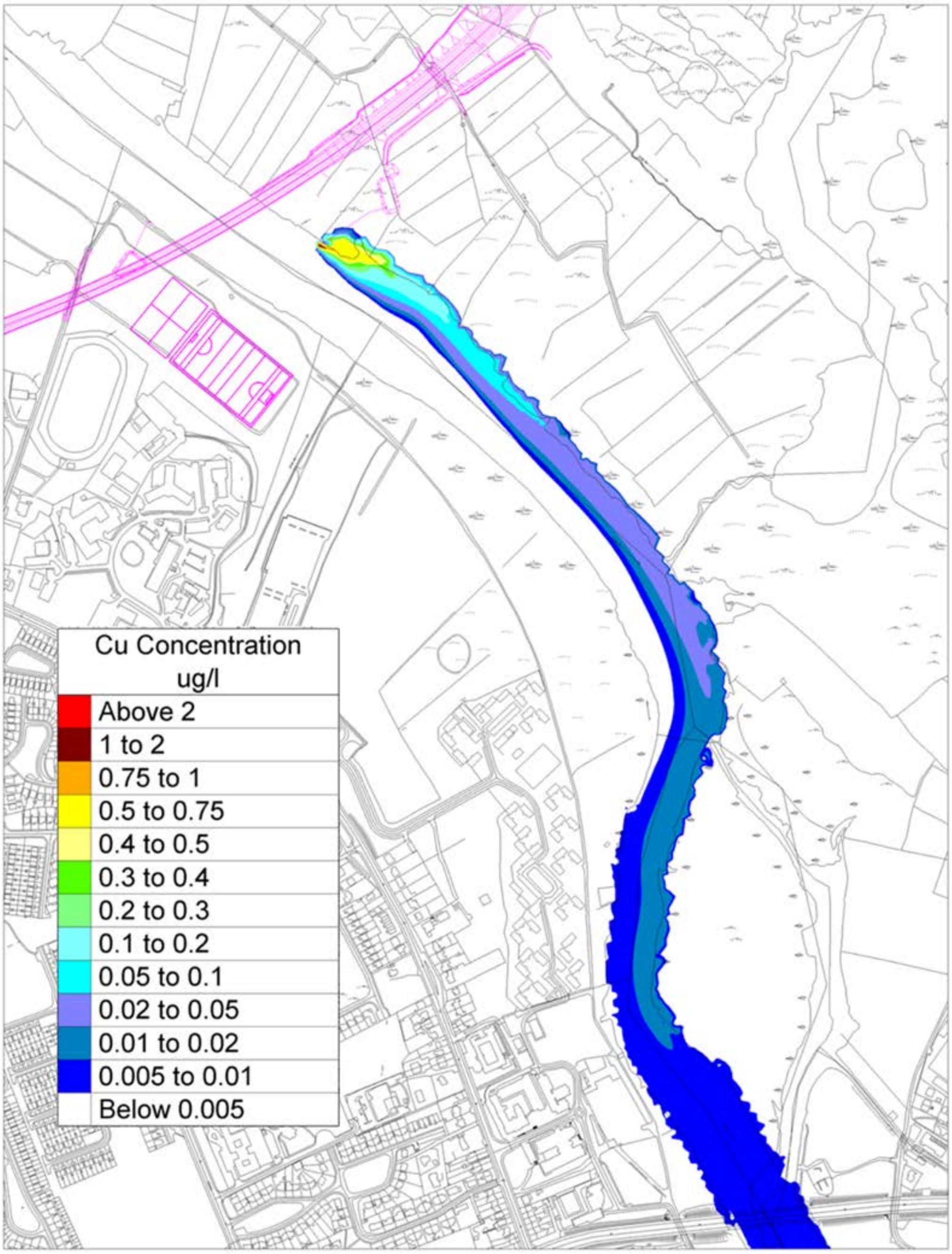


Plate 11.3: Maximum Dissolved Copper Concentrations for First Flush Storm Water Event and 95% River Corrib Low Flow for Dangan Outfalls (14A, 14B, 15 and 18A)

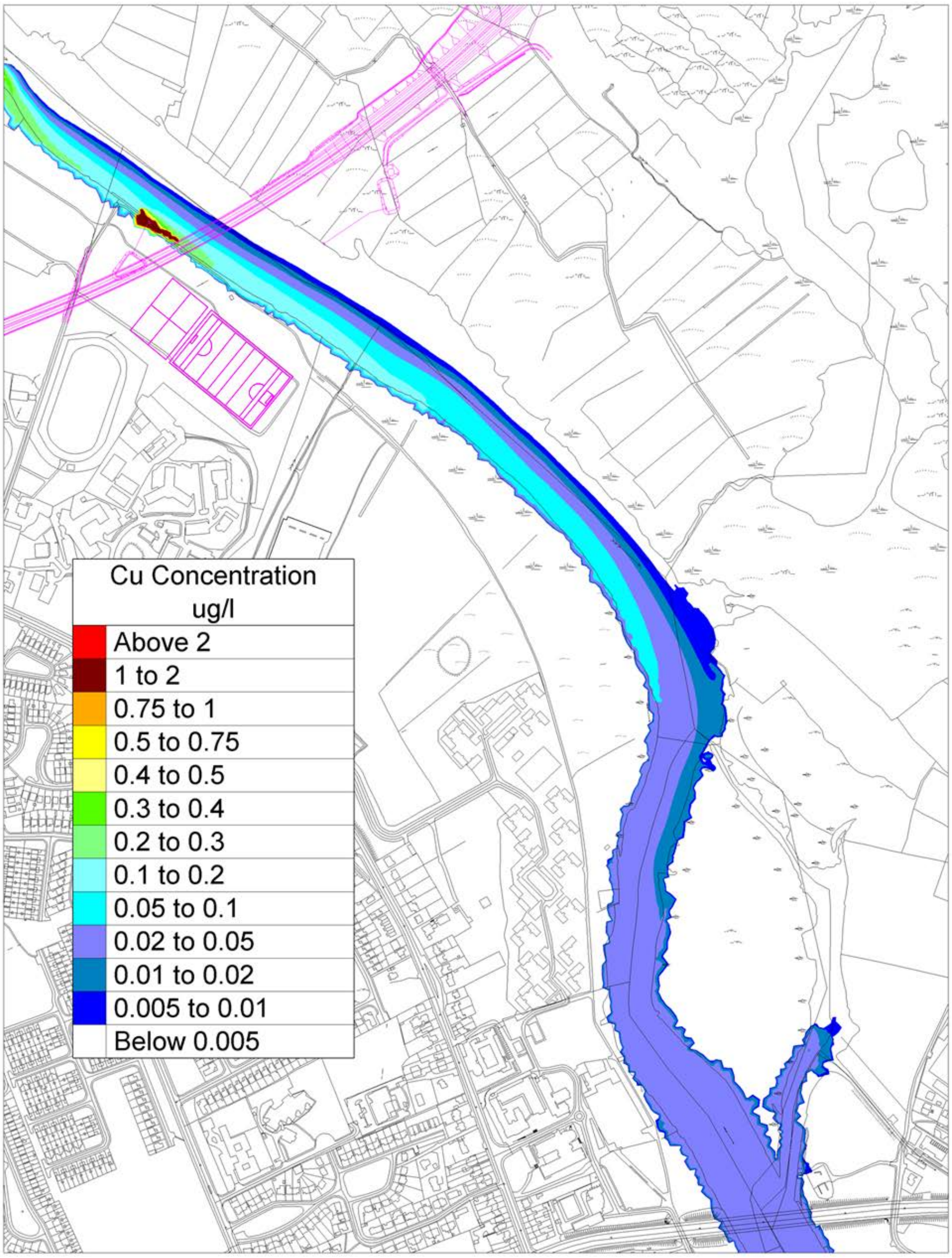


Plate 11.4: Maximum Dissolved Copper Concentrations for First Flush Storm Water Event and 95% River Corrib Low Flow for all combined Outfalls (14A, 14B, 15, 18A and 18B)

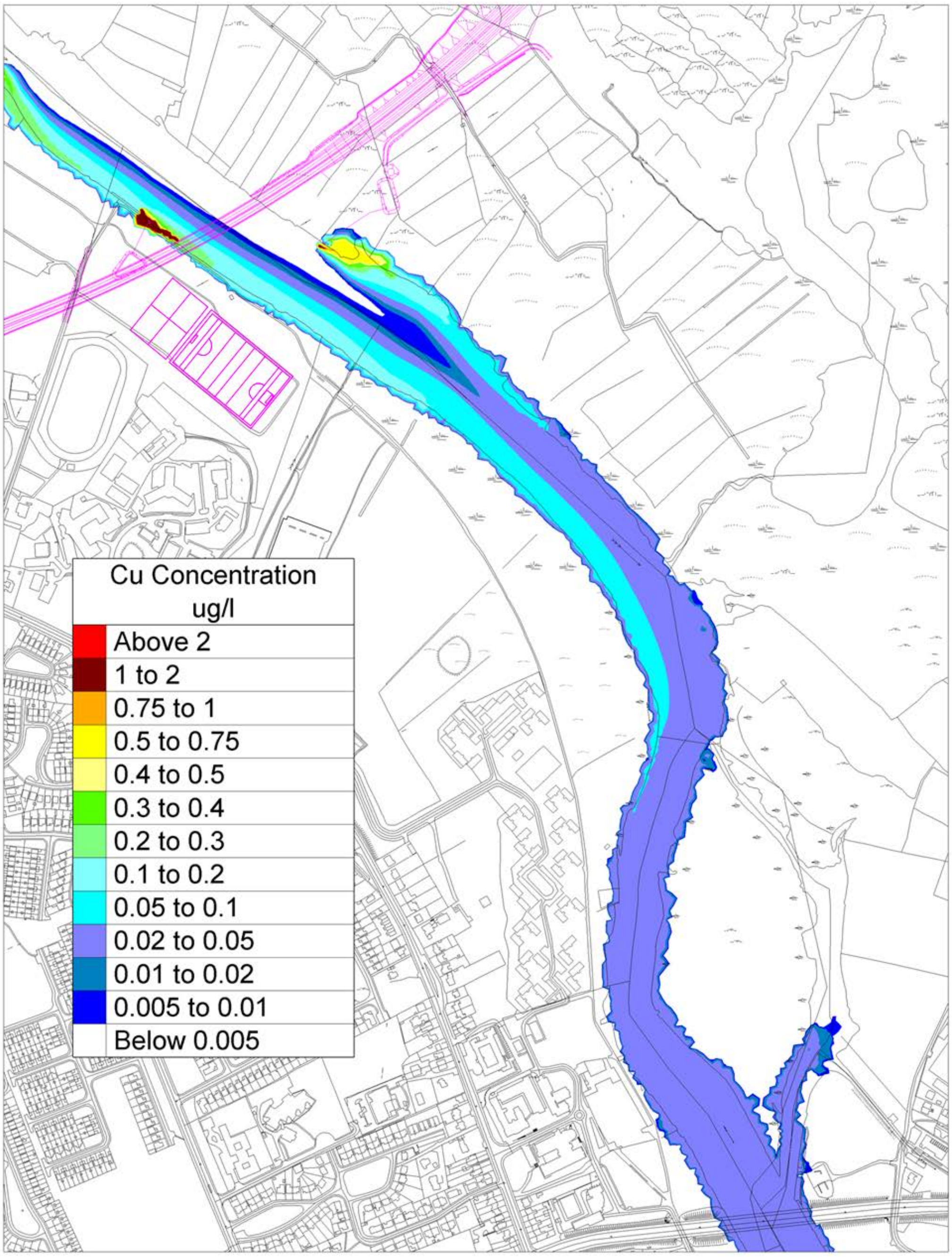


Plate 11.5: Maximum Dissolved Copper Concentrations for First Flush Rain Storm Event and median River Corrib Flow (82cumec) for all combined Outfalls (14A, 14B, 15, 18A and 18B)

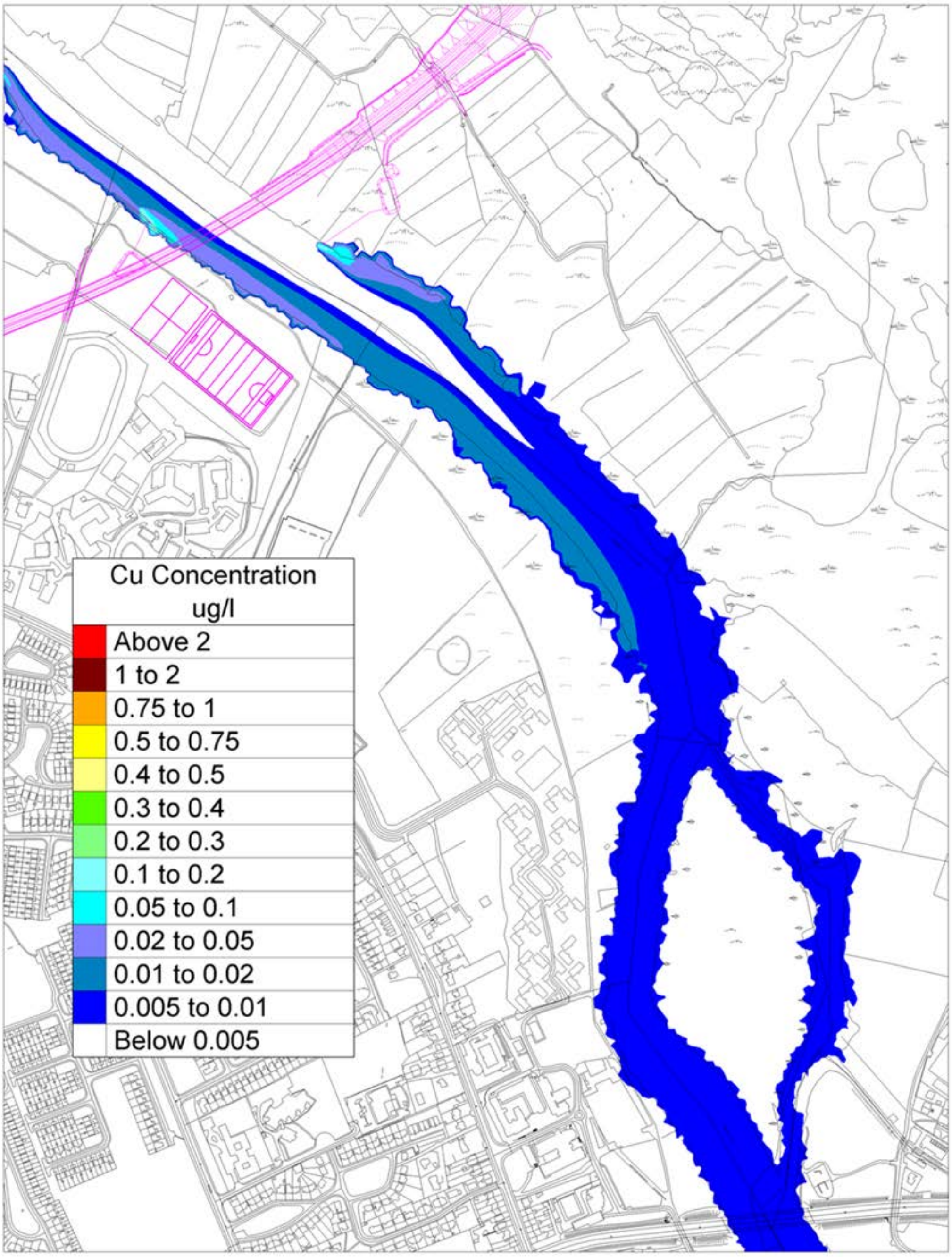


Plate 11.6: Maximum Dissolved Zinc Concentration for First Flush Rain Storm Event and 95% River Corrib Low Flow (14cumec) for all combined Outfalls (14A, 14B, 15, 18A and 18B)

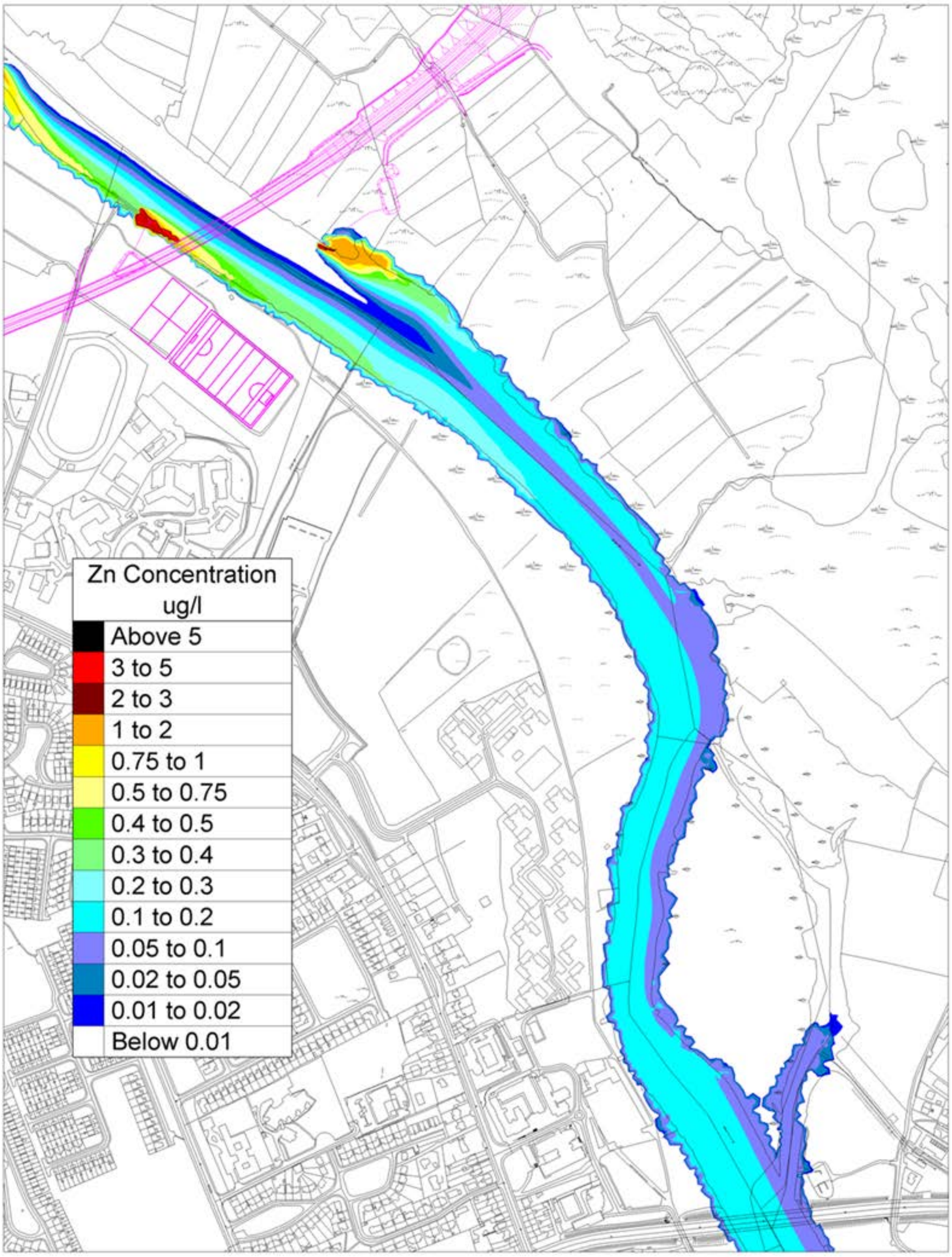
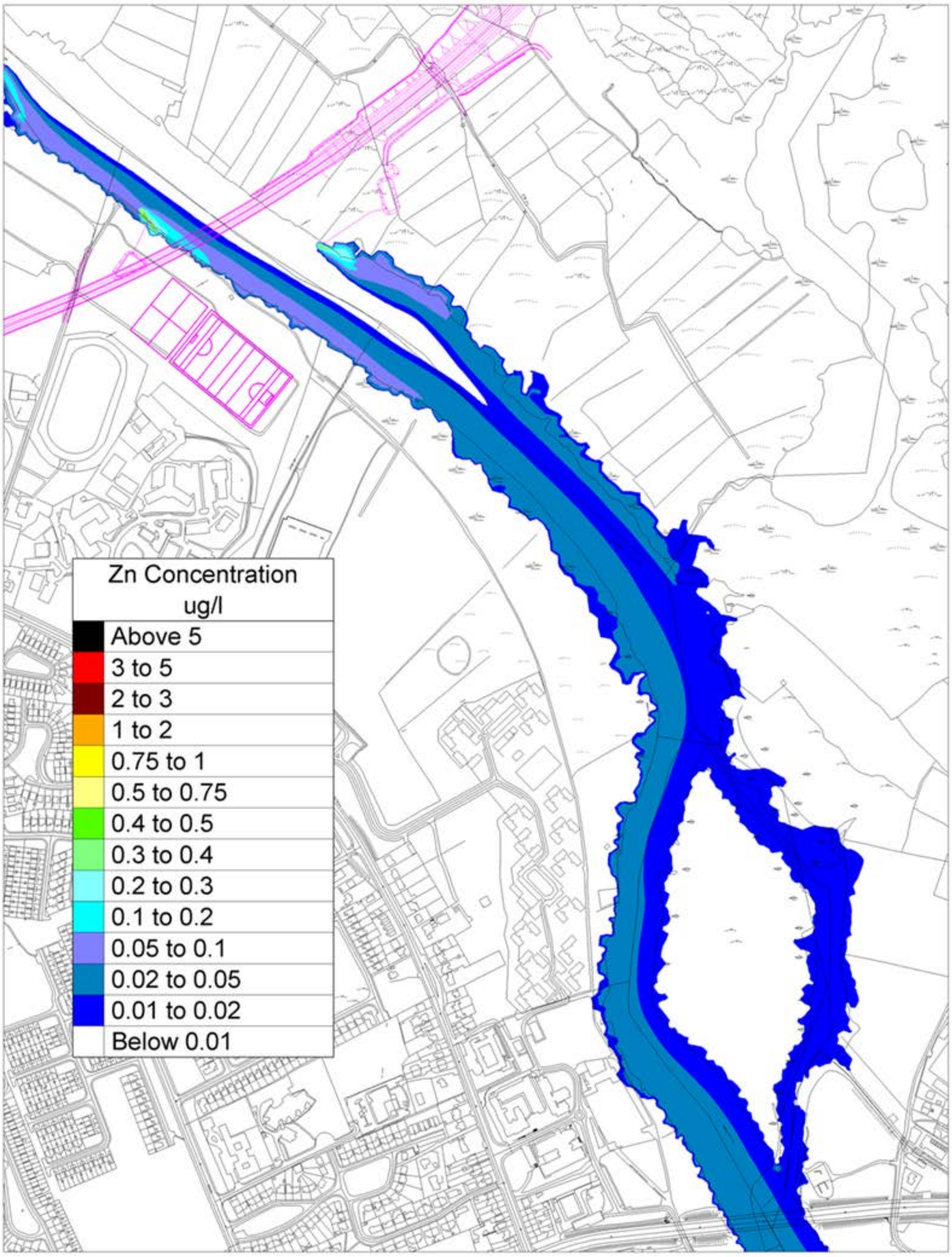


Plate 11.7: Maximum Dissolved Zinc Concentrations for First Flush Rain Storm Event and median River Corrib Flow (82cumec) for all combined Outfalls (14A, 14B, 15, 18A and 18B)



Detailed Assessment of Coolagh Lakes

The Coolagh Lakes and surrounding riparian lands form part of the Lough Corrib cSAC. The proposed road development traverses the Coolagh Lakes catchment from Ch. 9+700 to Ch. 11+800. There are no proposed direct storm water discharges to the Coolagh Lakes with all proposed road drainage discharges to groundwater via engineered infiltration basins. This runoff water drains into the limestone bedrock aquifer and ultimately some of this drainage water potentially recharges the Coolagh Lakes system. The protection of the groundwater quality is dealt with in detail in **Chapter 10, Hydrogeology**, with the infiltration basin and wetlands systems at each of these groundwater outfalls designed to remove pollutants and protect the highly vulnerable, regionally important, groundwater aquifer from adverse impacts by the proposed road drainage runoff. These groundwater quality design measures will also prevent impact to the hydrochemistry of the Coolagh Lakes through removal of pollutants via provision of a deep soil filter and generous infiltration areas at the relevant outfalls S19A and S19B and S20. The impact on the Coolagh Lakes water quality is rated as an imperceptible impact.

Detailed Assessment of Ballindooley Lough

The mainline section of the proposed road development from N84 Headford Road Junction to N83 Tuam Road Junction will be serviced by outfall S21B which is designed to discharge to groundwater in the vicinity of Ballindooley Lough where the groundwater flow gradient is southwards away from the lough. As a consequence, there will be no water quality or flow regime impacts on the lough from the mainline carriageway of proposed road development during the operational phase.

A single outfall S21A servicing the on-off slip roads and 250m of the existing N84 Headford Road at the N84 Headford Road Junction will discharge via a ditch to Ballindooley Lough system, entering the small lough to the southwest first which is connected to the bigger lough by a wide, straight c.200m long drainage channel. The total drainage area for this section is 3.31ha and the impervious road area is 1.36ha. This represents an average inflow rate of 0.3l/s and the annual average catchment drainage inflow is 20l/s from its 225ha catchment area presenting an average dilution of 67. Ballindooley Lough potentially represents a sink for sediment with the lake rising and falling with the groundwater table and in dry weather periods its water level remains perched above the receding groundwater table.

This proposed outfall is designed with pollution control measures that include a spillage containment volume, a petrol-oil interceptor, a wetland and an attenuation pond. These measures will reduce the potential sediment load on Ballindooley Lough by well over 60%. Circa 1.4km of the existing N84 Headford Road carriageway discharges untreated and uncontrolled surface water into Ballindooley Lough via road side trenches and storm pipes.

An assessment of the predicted loads and concentrations from road runoff from this outfall are presented in **Table 11.39** below. The annual mean concentrations of dissolved copper and zinc will rise by 0.399 and 1.417 µg/l respectively based on Event Mean concentrations and loads for significant road drainage pollutants in accordance with Table 3.1 of the TII publications DNS-03065. All other parameters considered below in **Table 11.39** represent minor increases and will not affect the water quality status of Ballindooley Lough.

Table 11.39: Predicted mean load of Stormwater Pollutants from Outfall S21A and predicted mean increase in pollutant concentration within Ballindooley Lough from S21A

Main Road Drainage Pollutants	Road Runoff Load	Road Runoff Event Mean Concentration	Pollution Control Performance	Lake mean storm Inflow Concentration	Mean Lake Concentration increase
	kg/yr	μg/l	%reduction	μg/l	μg/l
Total Copper	863	91.2	60%	36.48	0.547
Dissolved CU	296	31.3	15%	26.605	0.399
Total Zinc	3336	352.6	60%	141.04	2.116
Dissolved ZN	1051	111.1	15%	94.435	1.417
Total Cadmium	5.96	0.63	60%	0.252	0.004
Total Fluoranthene	9.65	1.02	60%	0.408	0.006
Total Pyrene	9.74	1.03	60%	0.412	0.006
Total PAH	71.1	7.52	60%	3.008	0.045

Please note the predicted lake concentrations in **Table 11.39** above do not take reducing factors such as filtration and absorption and settlement within the lake, or of plant uptake and natural biodegradation.

The proposed road development will have a negligible impact on the flow regime within the lake from the proposed road drainage outfall and the slight encroachment of the proposed road development into an extreme winter flood area. The overall water quality impact on the lake is classified as slight permanent impact and particularly as circa 1.4km of the N84 Headford Road already discharges uncontrolled and untreated to the lake catchment. The proposed road discharge is treated and the remaining sediment is likely to settle out locally within the small lake and this represents a potential moderate local impact on the lake sediments. The overall hydrological impact rating of the proposed road development on Ballindooley is classified as a local slight permanent impact.

11.5.5 Surface Water Supply Sources

There are two very large public surface water abstractions in proximity to the proposed road development. These are the Luimnagh regional water abstraction from Lough Corrib located over 15km upstream (north) of the proposed crossing point of the proposed road development of the River Corrib and the Terryland Galway City water supply abstraction from the River Corrib at Jordan's Island located 1.7km downstream of the crossing point on the eastern side of the river. The proposed road is not within the zone of contribution to the Luimnagh supply being located well downstream, whereas, the proposed road development is in close proximity to the Terryland Galway City supply intake having a travel time of potentially only 30 minutes to 2 hours to this abstraction point depending on the flow magnitude of the River Corrib. By virtue of the Luimnagh Lough Corrib abstraction being located over 15km upstream there will be no potential water quality impact from the proposed road development either during construction or operation phases.

The proposed road development will not have any perceptible impact on River Corrib flows and therefore will not impact the Terryland abstraction in terms of quantity of supply.

The close proximity of the proposed road development to the Terryland Galway City water supply intake, located within the immediate source contribution area, any pollution of the River Corrib by the proposed road development either during construction (construction runoff, construction accidental spillages (concrete, hydrocarbons), etc.) or during operation (spillages from road accident and routine road runoff) from the various contributing road drainage outfalls S14A, S14B, S15, S18A and S18B) has a high potential of reaching and contaminating the abstraction point at Jordan’s Island. This is particularly so for activities on or near the eastern bank. The abstraction is less sensitive to activities and discharges on the western bank but can still potentially be impacted given the right flow and meteorological conditions (southerly and westerly winds). The Terryland Galway City water supply is a fully treated water supply with tertiary treatment which provides some protection against significant impact by the proposed road development in the event of worst case spillage incident.

The dispersion analyses modelling of the River Corrib storm outfalls for the operational phase drainage discharges shows only trace pollutant concentrations reaching Jordan’s Island channel and the Terryland Galway City water supply intake under the critical first flush design conditions and can be concluded that the impact of routine road drainage runoff on the water quality of the Terryland Galway City water supply abstraction will be imperceptible.

The outfall spillage risk assessment indicates very low potential for serious accidental spillage and by the provision of outfall control facilities in the design, the potential impact from the operational phase of the proposed road development is rated as slight. Construction activities without adequate construction management mitigation measures, particularly on the eastern river bank have the potential to impact on this important abstraction which has a regionally important attribute value. Taking account of the good dilution available in the River Corrib, the avoidance of any major instream works in the channel, and the water treatment process available at the Terryland Galway City water supply treatment works to purify the water for public consumption, this construction impact is rated as a potential slight to moderate temporary impact. Notwithstanding this, a serious spillage has significant consequences and therefore mitigation measures to prevent construction based activities polluting the River Corrib are necessary.

Other water rights downstream are associated with the canals and various headraces both immediately to the east and west of the River Corrib channel through Galway City. The proposed road development will have an imperceptible impact on the flow regime and water quality of the River Corrib through Galway City and therefore will not impact flows and water quality in the various canals and main river channel.

11.5.6 Flood Risk

A Flood Risk Assessment (FRA) of the proposed road development in accordance with the Planning System and Flood Risk Management Guidelines (2009) was carried out and the FRA Report can be found in **Appendix A.11.1**. This assessment investigated the potential flood risk to the proposed road development itself and the potential flood impact arising from the proposed road development. A summary of the findings of the FRA is presented below.

Road developments by their nature traverse watercourses and flood risk areas along their selected route. The proposed road development will involve the crossing of 17 small watercourse channels requiring culverting, the local diversion/realignment of a number of these watercourses and road drainage outfall discharges to these watercourses at a proposed 23 number outfalls. The proposed road development involves a major bridge crossing over the River Corrib at Dangan, the encroachment of a number of small pluvial flood risk areas, wet grassland areas, the very slight encroachment of the River Corrib Floodplain adjacent to the Coolagh Lakes and the Ballindooley Lough floodplain. The proposed reconfiguration/redevelopment of the NUIG pitches at Dangan is shown to slightly encroach the River Corrib floodplain area. The most significant flood risk area that is encroached by the proposed road development is a large pluvial flood risk area adjacent to the N83 Tuam Road Junction at Twomileditch.

The vertical alignment of the proposed road development has been assessed against predicted fluvial, pluvial and groundwater flood levels and found to be sufficiently clear of flooding under both present day and future climate change scenarios. The proposed road development is not subject to any coastal flood risk being sufficient elevation naturally even with high range sea level rise of 1m.

The proposed bridge structure over the River Corrib is a 153m bridge span and avoids any instream piers and avoids the River Corrib floodplain width at the predicted 100year and 1000year flood levels. The potential impact of the proposed River Corrib bridge structure on flooding and flood risk has been shown through detailed modelling presented in the FRA Report in **Appendix A.11.1** to have no discernible impact on flood levels. The River Corrib Bridge crossing is considered not to present a residual flood risk as structure completely spans the floodplain width, no instream weirs and a soffit to flood level clearance of over 10m giving no opportunity of blockage by floating debris. Section 50 (1945 Arterial Drainage Act) approval has been granted by the OPW, who are the competent authority in respect to Flood Risk Management in Ireland, for the proposed River Corrib Bridge.

There is minor encroachment by the embankment of the proposed road development on the River Corrib floodplain near the Coolagh Lakes section at Ch. 9+890. This represents a very minor encroachment and will not result in a perceptible impact on flooding or on the active flow regime of the River Corrib and the Coolagh Lakes themselves and therefore such impact is rated as an imperceptible flood impact.

The proposed redevelopment of the NUIG pitches at Dangan represents a slight encroachment of the River Corrib’s 100-year and 1000-year flood zones at Dangan. The development of the pitches is likely to result in the raising of land so that the pitches are free from flooding and can drain effectively. The potential loss of floodplain storage is miniscule in comparison to the available flood storage in the River Corrib catchment and will not impact the flow regime in the River Corrib or affect flood risk elsewhere. Recreational/sports pitches are considered to be a suitable type of development within high and moderate flood zones A and B under the flood risk management planning guidelines.

At total of 16 small watercourses and drains will be crossed by the proposed road development and subsequently will be culverted. The topography and small catchment areas associated with these watercourses ensures that the associated flood zones for these streams is very localised having relatively narrow floodplain widths along these streams. The proposed culvert sizes are very generous and will not result in any constriction to flow and therefore any impact on flooding and flood risk is categorised as a slight permanent negative impact. Section 50 approval has been obtained from the OPW concerning flooding and flood capacity of all proposed culverts. The impact of all of the proposed culvert and bridge structures on flood water level and flood risk to properties is rated as imperceptible. All new culverts represent a residual flood risk in that serious blockage could cause local flooding.

A slight encroachment on the Ballindooley Lough flood zone by the embankment of the proposed road development is predicted and the effect of this has been assessed as minor and the impact on flooding assessed as a slight permanent impact.

There is a potential flood risk to the proposed Lackagh Tunnel from elevated groundwater table combined with pluvial flooding within the quarry. This risk is associated with the potential for elevated flood levels within the quarry floor, under extreme 1000-year flood events and climate change conditions, to potentially enter the tunnel from the eastern portal entrance on the quarry side. As the proposed road development traverses through the quarry, it will reduce the available storage for rainfall and increase pluvial ponding depths contained within the lower bench of the quarry. This could potentially increase flood levels local to the quarry. The potential risk is significant but has been reduced to slight by design, through raising the minimum road level at the tunnel portal entrance by 1m above the recorded historical worst flooding event (highest recorded winter groundwater level is 15.7m OD. and lowest design road level is 16.735m OD). Such a clearance, given the limited drainage catchment area, is considered sufficient to minimise flood risk. Topographically the quarry area is self-contained and the proposed infilling as a result of the proposed road development will not result in flood waters spilling from the quarry and causing flooding elsewhere with flood waters retained and receding with the groundwater table. Permeable infill material is recommended for use within the quarry so as to maintain the drainage route to groundwater through it limestone base and sides.

Road drainage outfalls discharging to limited capacity (flow and infiltration capacity) surface and groundwaters sources are provided with suitably sized flow control and attenuation and infiltration basins. The flow controls are designed to achieve greenfield flood runoff rates in the case of surface water outfalls, and soil infiltration capacity in respect to groundwater outfalls. Flood attenuation for the River Corrib outfalls from S18A and S18B is not required due to the large scale of the River Corrib catchment and its flood response time relative to the proposed storm discharge. The potential impact rating of the storm drainage outfalls on the receiving waters with respect to flow regime and morphological changes, and as such flood risk is presented in **Table 11.29**. This generally represents slight to imperceptible permanent impacts. The provision of infiltration basins and attenuation ponds represents a residual flood risk in respect to the continued design performance in respect to preventing local flooding and flood impact.

The provision of infiltration basins and attenuation pond facilities throughout the proposed road development represent a potential new source of flood risk as by their nature they temporarily impound road drainage waters and release slowly to the receiving waters. These are engineered structures designed to deal with 1 in 100-year storm event with allowance for climate change and freeboard. Proposed design water depths vary from 1 to 1.85m and therefore represent a relatively low flood risk under normal operating conditions. In addition, infiltration basins are sized such that half of the basins volume will empty in 24 hours or less which facilitates space for consecutive storm events. However, such facilities may be subject to potential blockage and therefore overtop giving rise to potential local flooding. Flow control devices which have small orifice sizes in order to restrict flows to greenfield runoff rates can be prone to blockage.

The residual flood risk is minimised in the design as the following maintenance schedule for the proposed road development drainage infrastructure:

- Regular inspections of all drainage facilities that include, culverts, flow control devices, outfalls, attenuation ponds and infiltration basins and the road drainage network to ensure that the drainage system is in proper working order and performing as designed

Several small pluvial flood sources are encountered along the proposed road development associated with small local depressions which will be either fully or partially removed and are highlighted in the FRA Report in **Appendix A.11.1**. The assessment indicates that these pluvial flood sources are very minor in respect to contributing drainage area and the extent of the flood area and the infilling of these will not result in significant impact on flooding, with the potential impact assessed as slight to imperceptible.

A large pluvial flood risk area near the existing N83 Tuam Road at Twomileditch is encroached by the proposed road development. This area has a significant flood risk with up to seven dwellings and the existing carriageway of the N83 Tuam Road at high risk of flooding (currently). The existing road and a number of dwellings have experienced flooding in the recent past. The critical flood levels for flooding on the N83 Tuam Road and adjacent dwellings is 18.0m to 18.5m OD. The local authority regularly deploy pumps to clear flooding from the existing road in this area. The proposed road development potentially encroaches the pluvial Flood Zone A (high probability of flooding zone) with the potential for 21.2% to 22.4% loss in available flood storage within these pluvial flood prone lands at a flood level of 18m and 18.5m OD respectively. Without suitable mitigation, the proposed road development has a potential at this location to remove flood storage and potentially worsen the flood risk at this location. This loss of flood storage represents a significant permanent impact on flooding and flood risk and therefore requires specific flood mitigation. In addition to the loss of storage, the proposed road development will also introduce a significant additional paved area to the contributing catchment of this flood zone. However, the drainage of this paved runoff area is designed to dispose separately to groundwater via a number of appropriately located and sized infiltration basins which minimises the contribution of the road pavement runoff to flooding at this location. The specific flood mitigation measures are dealt with in detail below in Section 11.6.

The proposed N59 Link Road South from Ch. 1+550 to 2+200 and the proposed upgrade / realignment to the Gort Na Bró and the Rahoon to Western Distributer Road are shown to be extensively located in the fluvial Flood Risk Zone A (High Flood Risk) of the Knocknacarra Stream, based on the Galway City Strategic Flood Risk Assessment (SFRA) Flood Zone mapping prepared by JBA (30 September 2015) and the OPW pFRA mapping. Both the Galway City Council SFRA and the OPW pFRA mapping are very coarse and did not include details of the stream channel or its various culverts. The assessments used the EPA/OSI historic watercourse alignment which no longer exists having been replaced and realigned by a large storm water pipeline as part of land development initiative. This flood risk mapping only allowed for overland flow based on poor resolution DTM lidar data and did not include for channel / storm pipe conveyance. Examination of this flood risk mapping against the OPW lidar 2m DTM ground levels clearly indicates that this mapping is unrealistic and coarse as the flood outline does not follow the local contours. As part of the FRA for the proposed road development the Knocknacarra Stream storm pipe trunk main was modelled using the Microdrainage software program with pipe invert levels, pipe diameters, manhole locations and cover levels specified using the storm drainage data provided by Galway City Council. The estimated design flows from the FSU method were input at the various nodal points of the storm sewer model and the micro-drainage program ran. The model results showed ample capacity within the storm pipe at both the 100 and 1000-year flood events not to result in flooding in the vicinity of the proposed N59 Link Road South or the various realigned junctions at Gort Na Bró and the Rahoon to Western Distributer Road. It is concluded that the proposed road development does not encroach the floodplain area or the flood risk zones of the Knocknacarra Stream and therefore will not impact on flooding. In keeping with the Galway City Sustainable Urban Drainage policy all storm discharge from the proposed road development to the Knocknacarra Stream will be attenuated to the natural greenfield runoff rates and therefore will not impact flood flows and flooding.

11.5.7 European Sites

Lough Corrib cSAC and Lough Corrib SPA

A summary of the potential hydrological impacts on the Lough Corrib cSAC are provided in in **Table 11.39**. The proposed road development via its drainage outfalls will provide a pathway for road runoff pollutants to enter the Lough Corrib cSAC and Lough Corrib SPA during construction and operational phases. Only one outfall S15 from the N59 Link Road North has a potential pathway via a drainage ditch that discharges to the River Corrib in the vicinity of the southern extent of the Lough Corrib SPA. The potential impacts from the operational phase have been reduced in the design process to minor and imperceptible both in respect to flow regime changes and water quality impact.

The potential impact of the proposed road development on the surface hydrology of the Coolagh Lakes system will be imperceptible. The proposed road development represents a potential pollution hazard and has a residual risk of pollution via contamination of the groundwater at its proposed infiltration basin. Proper management and regular inspection and maintenance of these drainage discharge facilities will significantly reduce the risk of pollution impact on the groundwater and the Coolagh Lakes system.

Galway Bay Complex cSAC and Inner Galway Bay SPA

A summary of the potential hydrological impacts on the Lough Corrib cSAC are provided in in **Table 11.40**.

The proposed road drainage treatment, the good natural buffering from the receiving watercourses before reaching the Galway Bay Complex cSAC and Inner Galway Bay SPA and the natural high dilution within the coastal and transitional waters of these European sites ensures that the residual impact on flow and water quality within the Galway Bay Complex cSAC and Inner Galway Bay SPA both locally and regionally will be negligible.

Construction impacts arising from the proposed road development represent a low risk to water quality within the Galway Bay Complex cSAC and Inner Galway Bay SPA due to the available buffering by the watercourses and by the high dilution within these European sites.

11.5.8 Water dependent habitats outside of a European site

The proposed road development traverses through and adjacent to the various water dependent habitats located outside of the European site. These habitats types encountered which have been mapped and described in **Chapter 8, Biodiversity** are summarised below in **Table 11.40**.

Table 11.40: Summary of water dependent habitats

Habitat Code	Habitat Name	Status
Fossitt Code PF1	Rich Fen and Flush	Non-Annex
Fossitt Code PF2	Poor Fen and Flush	Non-Annex
Annex Code 4010	Wet Heath	Annex I
Annex Code 6410	Molina Meadows	Annex I
Annex Code 7130	Blanket Bog (active)	Annex I
Annex Code 7140	Transition Mire	Annex I
Annex Code 7150	Rhynchosporion Depression	Annex I

The proposed road development has the potential to impact the water balance of water dependent wetland habitats through the potential diversion of overland and interflow that supplies these wetlands either through interception in the embankment toe drains, the subsurface filter drains, interceptor drain and by drainage in the road formation layer. **Table 11.41** presents an assessment of the impact to adjacent wetland habitats.

Table 11.41: Hydrological Impact Assessment on Water dependent habitats outside of a European site

Wetland Code	Habitat	Approx. Chainage	Location	Potential Impact
4030/4010	Mosaic of dry and Wet heath	0+700	Within proposed development boundary and to northwest	A toe drain of the proposed road development will drain a small section of this habitat, the potential hydrological impact will not extend beyond the hydrogeology ZOI
4010	Wet heath	0+700	Extends to within 30m north of the proposed development boundary	Wet heath located up gradient of the proposed road surface drainage. This habitat will not be impacted hydrologically
PF2/GS4	Poor Fen and Flush and wet grassland	0+750	Extends to within 20m north of the proposed development boundary	Located up gradient of the proposed road surface drainage. This habitat will not be impacted
4010	Wet heath	0+950	Within proposed development boundary	Habitat removed / lost. Refer to **Chapter 8, Biodiversity** for full details on habitat loss or removal
6410	Molinia Meadows	0+900	North of road	Located up gradient of the proposed road surface drainage. This habitat will not be impacted hydrologically
4010	Wet heath	1+250	Within proposed development boundary	Habitat removed / lost. Refer to **Chapter 8, Biodiversity** for full details on habitat loss or removal
4010	Wet heath	1+350	Within proposed development boundary	Slight encroachment and local drainage impact. The surface drainage impact will not extend beyond the hydrogeology ZOI
4010	Wet heath	1+450	Extends to within 30m Southwest of Road proposed development boundary	Located up gradient of the proposed road surface drainage. This habitat will not be impacted hydrologically
4010	Wet heath	1+400 - Na Foraí Maola to Troscaigh Link Road	Extends to within 8m north of Road proposed development boundary	Located up gradient of the proposed road surface drainage. This habitat will not be impacted hydrologically

Wetland Code	Habitat	Approx. Chainage	Location	Potential Impact
4010	Wet heath	1+750 to 2+400	Extends typically to within 50m north of Road proposed development boundary	Located up gradient of the proposed road surface drainage. This habitat will not be impacted hydrologically
4010	Wet heath	1+850 to 2+100	Located within and immediately north and south of proposed development boundary. Topography generally flat.	Habitat removed and local drainage effect both north and south of the proposed road toe drains. The surface drainage impact will not extend beyond the hydrogeology ZOI
4010	Wet heath	2+700	South(60m) and 40m west of Bearna-Moycullen Road	Located up gradient of the proposed road surface drainage. This habitat will not be impacted
6410	Molinia Meadows	2+850 to 2+950	130m south	Surface drainage at this habitat will not be impact by the proposed road development
4010	Wet heath	3+450 to 3+700	Extends to within 50m southeast of Road proposed development boundary. Habitat located downgradient and within the ZOI of the road	A small local drain that runs along the downstream boundary of this habitat will be diverted. The proposed road drainage and formation layer will capture and divert contributing overland and interflow away from this habitat. Potential Moderate Impact on the surface hydrology of this habitat. The groundwater ZoI does not extend downstream to this habitat and therefore it is likely that this habitat will not be lost
6410	Molinia Meadows	3+600	west of proposed development boundary	Located up gradient of the proposed road surface drainage. This habitat will not be impacted hydrologically
6410	Molinia Meadows	3+600	30m east of proposed development boundary	Habitat located downgradient with potential drying effect through interception of overland and interflow by road drainage and road construction. The hydrogeological ZoI does

Wetland Code	Habitat	Approx. Chainage	Location	Potential Impact
				not extend downstream to this habitat and therefore it is likely that this habitat will not be lost. Potential Slight Impact on the surface hydrology of this habitat
4010	Wet heath	3+650 to 3+800	Habitat within proposed development boundary	Habitat removed / lost. Refer to **Chapter 8, Biodiversity** for full details on habitat loss or removal
4030/4010	Mosaic and dry and Wet heath	3+750	Habitat generally Northwest and slightly within proposed development boundary	The proposed road development is in a cutting with drainage effect by interceptor drains and road filter drains. The surface drainage impact will not extend beyond the hydrogeology ZOI
4030/4010	Mosaic and dry and Wet heath	4+925	Habitat Northwest and slightly within proposed development boundary	The effect of the proposed road development drainage will not extend beyond the hydrogeology ZOI at this location
4010	Wet heath	5+075	located South and slightly within proposed development boundary	Slight local surface drainage effect on habitat by the proposed road development. The effect of the proposed road development drainage will not extend beyond the hydrogeology ZOI
4010	Wet heath	5+200	Extends to within 60m North of Road proposed development boundary	Located up gradient of the proposed road surface drainage. This habitat will not be impacted hydrologically
4030/4010	Mosaic and dry and Wet heath	5+250	Slight encroachment of Habitat within Fence Line	The effect of the proposed road development drainage will not extend beyond the hydrogeology ZOI
4010	Wet heath	5+850	Extends to within 110m North of proposed development boundary	No hydrological impact as habitat not within ZoI of road and surface drainage in area serviced by existing storm sewer

Wetland Code	Habitat	Approx. Chainage	Location	Potential Impact
7140	Transition Mire	7+450 and N59 0+700	80m NW of proposed development boundary and proposed construction compound area	No hydrological impact as habitat not within ZoI of Road being fed from the Northwest and North
7130	Blanket Bog (active)	7+550 and N59 0+650	10m NW of proposed development boundary and proposed construction compound area	No hydrological impact as habitat not within ZoI of Road being fed from the Northwest and North
PF2	Poor Fen and Flush	7+850	north and within proposed development boundary	The effect of the proposed road development drainage will not extend beyond the hydrogeology ZoI
6410	Molina Meadows	12+250	within and downstream near Ballindooley Lough	The effect of the proposed road development drainage will not extend beyond the hydrogeology ZoI
PF1	Rich Fen and Flush	12+350	Extends to within 70m NW of proposed development boundary	The surface drainage of this Habitat will not be impacted by the proposed road development

Local impacts to the local water chemistry in terms of changing the pH may apply where limestone derived alkaline material is placed over granite bedrock. Surface water run-off, interflow or groundwater movements through such material has the potential to impact local areas of peatland habitats by changing the pH of the recharge water particularly where this alkaline material is saturated (below the groundwater table). This potential impact will only apply to adjacent wetland habitats within hydrogeological Zone of Influence of the proposed road development. The use of limestone based road material for the pavement and capping layers is permitted as such layers will be protected from direct surface water and groundwater infiltration and located in the unsaturated zone above the groundwater table. This capping protection is provided by the road bitumen surface and the use of native topsoil capping along the grass verge and embankment section of the road construction. Restriction on the use of limestone derived formation material will apply locally to road sections in the vicinity of water dependent habitats within the granite bedrock area (west of the existing N59 Moycullen Road), refer to **Chapter 9, Soils and Geology** for details of mitigation.

A summary of the potential impacts on the Lough Corrib cSAC and Lough Corrib SPA is provided in **Table 11.42** below.

Table 11.42: Hydrological Impacts on Lough Corrib cSAC and Lough Corrib SPA

Attribute	Impact Stage	Nature of Impact	Impact description	Potential Impact Magnitude
Lough Corrib cSAC (00297), and Lough Corrib SPA (004042) River Corrib	Construction	Spillages (hydrocarbons, cement etc.) into watercourses and onto wetlands.	A major bridge construction is proposed across the River Corrib and associated with the bridge deck and the bridge piers will be the pouring of concrete and the use of chemical and grouting agents in close proximity to an internationally important waterbody. Due to the major public water abstraction located only 1.7km downstream on the east bank makes it highly sensitive to construction pollution and potential accidental spillages.	Moderate to Significant Temporary Impact requiring mitigation
Lough Corrib cSAC (000297), Lough Corrib SPA (004042) River Corrib Coolagh Lakes	Construction	Silts and sediments arising from works adjacent to watercourses and construction site runoff	Within the River Corrib Catchment, the various streams/drains encountered provide a pathway for silts and sediment laden runoff water from the construction site to reach the Lough Corrib cSAC and cause local increase in suspended solids and turbidity. These activities adjacent to the River Corrib and its floodplain provide a significant source and pathway for sediment laden runoff to enter the River Corrib with little buffer time available for natural filtering and settlement. The River Corrib Bridge crossing of the Lough Corrib cSAC at Menlo/Dangan will not involve any in-stream works but bridge piers are to be located on either bank close to the river edge which can give rise to site runoff entering the river during works. Two bank side drainage outfalls are to be constructed which given their proximity the river flow make it difficult to prevent local disturbance of sediments. Good dilution in the River Corrib significantly lessens the potential impact on the receiving waters The proposed construction of the NUIG pitches as part of the accommodation works for the Road has the potential during construction to pollute given their proximity of the pitches to the Corrib river bank and to a local drainage ditch to the southeast that discharges directly into the River Corrib. A section of the	Moderate to Significant Temporary Impact requiring mitigation

Attribute	Impact Stage	Nature of Impact	Impact description	Potential Impact Magnitude
			Pitch is shown to be within the 1 in 100year flood contour and therefore there is a small risk of flood inundation during construction which could further exacerbate sediment runoff to the Corrib There is potential for construction impact in the form sediment runoff and pollution associated with the road construction in vicinity of the Coolagh/Corrib Floodplain at Ch. 9+850.	
Lough Corrib cSAC (000297), Lough Corrib SPA (004042) River Corrib Coolagh Lakes	Operational	Changes to Flow regime within the River Corrib	The proposed road development slightly encroaches the River Corrib floodplain near Menlo / Coolagh Lakes at Ch. 9+850 to Ch. 9+900. The area of encroachment at the 1000year flood level is 0.27ha and at the 100year it is 0.11ha. The proposed encroachment will not have any perceptible impact on flooding or on the hydrological flow regime. Potential encroachment of the 100year flood extents will also occur at Dangan associated with the redevelopment of the NUIG pitches. The Pitches infill this floodplain area to achieve a free draining pitch These encroachments are very small and the potential flood storage loss from infilling will be miniscule in relation to the Corrib Flood area and flood volume and will no perceptible impact on flooding or flow regime in the Corrib and the Corrib cSAC and Corrib SPA. A number of road outfalls discharge directly and indirectly to the Corrib cSAC (outfalls S14A, S14B, S15, S18A, S18B) and Corrib SPA (outfall S15). These outfalls relatively to the Corrib drain a miniscule area and will have no perceptible effect on the flow rate and water depth of the Corrib River.	Slight to imperceptible permanent impact

Attribute	Impact Stage	Nature of Impact	Impact description	Potential Impact Magnitude
Lough Corrib cSAC (000297), Lough Corrib SPA (004042) River Corrib Coolagh Lakes	Operational	Impact on Receiving Water Quality of Corrib from Road Drainage at proposed road drainage outfalls	Within the River Corrib Catchment, the various streams/drains encountered provide a permanent pathway for pollutants from the road drainage waters to enter the River Corrib. The potential impact by the road drainage outfalls on the Lough Corrib cSAC and SPA have been assessed as local minor to imperceptible impact and will not affect the “Good” water quality status of the Corrib River. The potential risk of impact to the River Corrib by serious accidental road spillage has been assessed as extremely low risk and further reduced in the design process through the provision of containment facilities in the form of petrol and oil interceptors and wetland area upstream of the drainage outfalls	Slight permanent impact

A summary of the potential impacts on the Galway Bay Complex cSAC and Inner Galway Bay SPA is provided in **Table 11.43** below.

Table 11.43: Hydrological Impacts on Galway Bay Complex cSAC and Inner Galway Bay SPA

Attribute	Phase	Source	Impact description	Potential Impact Magnitude
Galway Bay Complex cSAC (00268) Inner Galway Bay SPA (04031)	Construction	Silts and sediments arising from in stream works and works adjacent to watercourses and construction site runoff.	The various streams encountered all along the proposed road development provide a pathway for silts and sediments runoff from the construction site to reach the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City which is typically located 1 to 2km downstream of the proposed road development and therefore at risk of indirect water quality impacts.	Slight Temporary Impact
	Construction	Spillages (hydrocarbons, cement etc.) into watercourses and onto wetlands.	Construction spillages similar to silts and sediments can reach the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City via surface runoff and via groundwater.	Slight Temporary Impact

Attribute	**Phase**	**Source**	**Impact description**	**Potential Impact Magnitude**
	Construction	Disturbance due to construction machinery and carrying out of temporary works (cofferdams, culverts, channel diversions, sediment ponds, silt fences etc.).	There is no direct encroachment of the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City by the proposed road development.	None
	Operational	Road drainage and outfalls impacting on the water quality Regime: - Routine road runoff discharges - Accidental fuel spills from road	There are no direct discharges from road drainage outfalls to the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City but most the road outfalls discharge to watercourses and groundwater aquifer that outfall to this cSAC/SPA and therefore provide a pathway for contaminants to reach the cSAC/SPA. The probability of accidental road accident spillages is shown to be very low and sufficient dilution available to minimise the impact of routine runoff on the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City.	None
	Operational	Changes to watercourse channel morphology because of culverting, diversions, channel regrading works and outfall discharges giving rise to short term erosion and deposition and morphological changes.	The proposed road development will not impact on morphological processes in the Galway Bay Complex cSAC and Inner Galway Bay SPA and particularly so as outfall discharges will be attenuated which will limit any local increase in flood runoff rates that could cause increased channel erosion. The sediment yield to the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City will not be perceptibly changed given the proposed works involved and the scale of the overall contributing catchments to the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City relative to the footprint of the proposed road development.	None

11.5.9 Material Deposition Areas

A total of 40 site areas have been identified as potential material deposition areas for the excess soft and unacceptable material along the route of the proposed road development, refer to **Table 11.27**.

These potential material deposition areas if not correctly constructed, could represent a serious source of pollution to an adjacent watercourse should untreated runoff waters containing high concentration of sediment from these facilities enter the watercourse.

These material deposition areas will be bunded or excavated sites and will have double erosion control fencing (silt fence) and a sediment settlement pond at the outlet which will be constructed in advance of their use as deposition areas. In addition, wheel wash facilities will be provided at the entrance/exit as outlined in the CEMP – see **Appendix A.7.5**.

Runoff from the material deposition areas will be treated in temporary settlement ponds which will be provided upstream of the outfall to the receiving watercourse or sewer. These ponds will be maintained until the material deposition areas have stabilised and become adequately vegetated. In addition, the specific construction sequence for these areas (described below) will allow for settlement of sediment prior to discharge to the receiving watercourse. The construction sequence of each of the material deposition areas is such that the area allocated for material deposition is compartmentalised to allow a deposition area to be first established in one compartment, while the runoff water from this compartment flows into and is contained within an adjacent compartment. This will allow settlement of sediment to take place. Once settlement of the sediments has occurred, this settlement area is then itself filled with peat and the adjacent compartment acts as the settlement area for the runoff from this section. This process is repeated as the works advance.

The construction sequencing and design of the material deposition areas will ensure that there will be negligible impact on adjacent watercourses. As part of the CEMP a plan for erosion and sediment control has been developed which deals specifically with the potential impacts of the material deposition areas and this is attached in **Appendix A.7.5**.

11.6 Mitigation Measures

11.6.1 Introduction

This section outlines the proposed mitigation measures for hydrology. Mitigation measures follow the principles of avoidance, reduction and remedy. The most effective measure of avoidance is dealt with during the route selection and design stage, by moving the proposed road development either laterally or vertically within the Emerging Preferred Route Corridor, to ensure that it does not traverse or pass near to sensitive hydrological attributes. As set out throughout **Section 11.4**, appropriate measures have been incorporated into the design of the proposed road development to avoid impacts where possible.

Where avoidance of the feature has not been possible, consideration has been given to locally modifying the proposed road development so as to reduce / minimise the extent of the impact. If any modifications are proposed to reduce hydrological impacts, it is necessary to also consider any associated impacts to the hydrogeological and ecological regimes.

11.6.2 Construction Phase

As is normal practice the Construction Environmental Management Plan (CEMP) included in **Appendix A.7.5** will be finalised by the Contractor in advance of the commencement of construction and the following will be implemented as part this plan:

- An Incident Response Plan detailing the procedures to be undertaken in the event of spillage of chemical, fuel or other hazardous wastes, logging of non-compliance incidents and any such risks that could lead to a pollution incident, including flood risks (Refer to Section 10 of the CEMP in **Appendix A.7.5**)
- A Sediment Erosion and Pollution Control Plan (Refer to Section 8 of the CEMP in **Appendix A.7.5**). This shall include water quality monitoring and method statements to ensure compliance with environmental quality standards specified in the relevant legislation (i.e. surface water regulations and Salmonid Regulations 1988)
- All necessary permits and licenses for instream construction works associated with the provision of culverts, bridges and outfalls. OPW Section 50 consent has been received for all culverts and bridges proposed in the EIAR. Changes to these structures as part of the detailed design and construction stage will require new Section 50 consent to be obtained
- Inform and consult with OPW Western Arterial Drainage Section who have responsibility for the Corrib-Mask Arterial Drainage scheme and the ongoing control of river and lake levels at the Salmon Weir Barrage in Galway City
- Continue to Inform and consult with Inland Fisheries Ireland (IFI)
- Continue to Inform and consult with National Parks and Wildlife Service (NPWS)

Construction activities will be required to take cognisance of the following guidance documents for construction work on, over or near water:

- Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters (Inland Fisheries Ireland, 2016)
- Shannon Regional Fisheries Board – Protection and Conservation of Fisheries Habitat with particular reference to Road Construction
- Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites (Eastern Regional Fisheries Board)
- Central Fisheries Board Channels and Challenges – The Enhancement of Salmonid Rivers
- CIRIA C793 The SuDS Manual
- CIRIA C624 Development and Flood Risk – guidance for the construction industry
- CIRIA C532 Control of Water Pollution from Construction Sites Guidance for Consultants and Contractors
- CIRIA C648 Control of Water Pollution from Linear Construction Projects, technical guidance
- CIRIA C649 Control of Water Pollution from Linear Construction Projects, site guide
- Guidelines for the Crossing of Watercourses during the Construction of National Road schemes (NRA, 2006)
- Road Drainage and the Water Environment DN-DNG-03065 (TII, June 2015)
- Vegetated Drainage Systems for Road Runoff DN-DNG-03063 (TII, June 2015)

Based on the above guidance documents concerning control of construction impacts on the water environment, the following outlines the principal mitigation measures that will be prescribed for the construction phase in order to protect all catchment, watercourse and ecologically protected areas from direct and indirect impacts:

- All constructional compound areas will be required to be located on dry land and set back from river and stream channels and out of floodplain areas. Floodplain areas include the Flood Risk Zones A and B (i.e. outside of the present day 100year and 1000year flood extents)
- The storage of oils, fuel, chemicals, hydraulic fluids, etc. will not occur within 100m of the River Corrib or within the Floodplain Area as defined above
- Surface water flowing onto the construction area will be minimised through the provision of temporary berms, diversion channels and cut-off ditches, where appropriate
- Management of excess material stockpiles to prevent siltation of watercourse systems through runoff during rainstorms will be undertaken. This may involve allowing the establishment of vegetation on the exposed soil and the diversion of runoff water off these stockpiles to the construction settlement ponds and avoiding stockpiling of material in vicinity of sensitive watercourses

- Where construction works are carried out adjacent to turloughs, fens, stream and river channels and lakes, protection of such waterbodies from silt load shall be carried out through use of reserved grassed buffer areas, timber fencing with silt fences or earthen berms. These measures will provide adequate treatment of constructional site runoff waters before reaching the watercourses
- Use of settlement ponds, silt traps and bunds and minimising construction activities within watercourses. Where pumping of water is to be carried out, filters will be used at intake points and discharge will be through a sediment trap or sedi-mat
- All watercourses that occur in areas of land that will be used for site compound/storage facilities will be fenced off at a minimum distance of 5m. In addition, measures will be implemented to ensure that silt laden or contaminated surface water runoff from the compound site does not discharge directly to the watercourse. Compounds shall not be constructed on lands designated as Flood Zone A or B in accordance with the OPW's The Planning System and Flood Risk Management Guidelines (November 2009). Site compounds will not be permitted in a European Sites (i.e. Lough Corrib cSAC)
- Protection measures will be put in place to ensure that all hydrocarbons used during the construction phase are appropriately handled, stored and disposed of in accordance with the TII document "Guidelines for the crossing of watercourses during the construction of National Road Schemes". All chemical and fuel filling locations will be contained within bunded areas and set back a minimum of 10m from watercourses
- Foul drainage from all site offices and construction facilities will be contained and disposed of in an appropriate manner to prevent pollution
- The construction discharge will be treated such that it will not reduce the environmental quality standard of the receiving watercourses
- Riparian vegetation along the identified sensitive watercourses will be fenced off to provide a buffer zone for its protection to a minimum distance of 5m except for proposed crossing points
- The use and management of concrete (which has a deleterious effect on water chemistry and aquatic habitats and species) in or close to watercourses will be carefully controlled to avoid spillage. Where on-site batching is proposed, this activity will be carried out well away from watercourses. Washout from such mixing plants will be carried out only in a designated contained impermeable area
- All material deposition areas must be adequately bunded and compartmentalised such that the rainwater outflow from these facilities is adequately controlled and treated prior to reaching the receiving surface watercourses. The sediment control requirements are set out in the in the Sediment, Erosion and Pollution Control Construction Management Plan section of the CEMP (refer to **Appendix A.7.5**).

The potential for constructional phase impacts on water quality in receiving streams and lakes has been reduced to slight and imperceptible through the implementation of a Sediment Erosion and Pollution Control Management Plan included in the CEMP in **Appendix A.7.5**.

The potential for constructional phase impacts on water quality in the Lough Corrib cSAC has been reduced to slight and imperceptible through the implementation of a Sediment Erosion and Pollution Control Management Plan., included in the CEMP in **Appendix A.7.5**.

To minimise the risk of contamination to the Galway Bay Complex cSAC a detailed Sediment, Erosion and Pollution Control Management Plan for the construction phase has been developed and included in the CEMP in **Appendix A.7.5**, which provides for avoidance, reduction, mitigation and monitoring. Construction hydrological and water quality impacts on the Galway Bay Complex cSAC and Inner Galway Bay SPA will be avoided.

11.6.3 Operational Phase

11.6.3.1 Flood Risk Mitigation

A single flood risk area adjacent to the N83 Tuam Road at Twomileditch is identified as being significantly impacted by the proposed road development with a potential loss of 21% of the available flood storage. This potential impact is identified as significant as the loss of flood storage will increase the extreme flood levels and increase the probability of flooding within an existing flood risk area where seven houses and the N83 Tuam Road are identified to be at high flood risk.

Without suitable mitigation the proposed road development will have a significant impact on pluvial flooding on these lands and will increase the flood risk to other properties.

The 100-year return period flood event with a 20% allowance for climate change design flood level for the proposed flood relief measures is 17.5m OD Malin which will prevent flooding of the driveways to the dwellings and the N83 Tuam Road.

The flood relief mitigation measures to eliminate the flood impact of the proposed road development and reduce the existing flood risk in this area are described as follows (refer also to Drawing GCOB-500-D-600):

- Prevent the upgraded portion of the N83 Tuam Road from spilling laterally northwards into the driveways of existing flood risk houses by:
  - Upgrade and provide effective road drainage network along the existing N83 Tuam Road. The proposed upgraded road drainage for the N83 portion is extends for a length of 780m
  - Provide interceptor drain to capture rapid hill slope runoff from the southeast reaching the N83 Tuam Road
  - Provide for infiltration of this interceptor drain for the less severe rain storm events
  - Connect this interceptor drain to the proposed flood compensation storage

- Compensate flood storage lost by providing compensation storage of 8,030m^3 in the form of an excavated rectangular engineered storage pond. The base elevation of 16m OD and a top design water level elevation of 17.5m OD
- Connect this compensation storage to the remaining low-lying natural flood storage area located to the northwest of the proposed road development so that both storage areas are hydraulically linked via culverts
- Provide for permanent a pumping station and rising mains from the proposed compensation flood storage facility to discharge to the existing storm sewer with maximum pumping capacity of 250l/s

Table 11.44 Outlines the required storage volumes required for the catchment for a range of return periods and durations events. The critical volumes for each return period are shown in bold text.

Table 11.44: Flood Mitigation Storage Volumes

Duration	Pumping	Storage Volume Required		
hours	**250 l/s**	**2yr**	**10yr**	**100yr**
1	900	5138	8208	13428
2	1800	6029	9662	15649
3	2700	6408	10451	16898
4	3600	**6532**	10830	18001
6	5400	6420	**11128**	19459
9	8100	5665	10833	20439
12	10800	4500	10267	**20687**
18	16200	1607	8659	19904
24	21600	0	6112	18008
48	43200	0	0	6388

The required flood storage with pumping of 0.25cumec is 20,700m^3 for the 100year event and including 20% climate change the storage required is 24,800m^3.

The available storage at a top water level of 17.5m OD is compensation storage of 8,030m^3 and remaining (with proposed road development) natural storage of 18,470m^3 giving a total available flood storage of 26,500m^3, which is sufficient to achieve that design standards.

Overall the proposed road development with this mitigation will provided a significant positive impact on flooding and flood risk in N83 Tuam Road in the Twomileditch flood risk area.

To minimise the residual flood risk associated with the blockage of flood relief culverts and associated drainage assets, the following operational mitigation measure is recommended:

- Regular (monthly) inspection of N83 Flood Relief facilities be carried out to ensure that the system is in proper working order and performing as designed.

11.7 Residual Impacts

The residual hydrological impacts associated with the proposed road development can be grouped as follows:

- Drainage and flood risk
- Water quality
- Channel morphology
- Potential impacts on key ecological receptors

11.7.1 Drainage and Flood Risk

There is a potential to increase peak flow rates and runoff volumes due to the increased impermeable area associated with the proposed road development and the collecting drainage system which discharges at outfall points. The implementation of SuDS through the incorporation of engineered wetlands, attenuation ponds, infiltration basins and controlled discharges at all outfalls will control storm runoff rates to greenfield flood runoff rates and will not exacerbate flooding and flood risk in the receiving watercourses. As part of the proposed drainage design attenuation storage has been sized to accommodate the 100-year storm event with 20% climate change allowance.

In the karst aquifer section east of the River Corrib, where surface drainage watercourse features are non-existent, the proposed road drainage system will convey rainfall from the impervious road pavement as drainage runoff to discharge, virtually a point source, to groundwater via engineered infiltration basins. Sizing of these basins, with facility for surcharging within the basin, has been designed to cater for the 100year flood event with 20% climate change allowance.

The provision of infiltration basins and attenuation pond facilities throughout the proposed road development represent a potential new source of flood risk as they by their nature impound road drainage waters and release slowly to the receiving waters. Such facilities may be subject to potential blockage and therefore overtop giving rise to potential for local flooding. The residual risk is low due to the standard regular inspections of such facilities, that include, culverts, flow control devices, outfalls, attenuation ponds and infiltration basins to ensure that system is in proper working order and performing as designed. Such facilities are considered to represent a slight magnitude permanent impact to flooding and flood risk.

With the relatively high density of drainage outfalls along the proposed road development there is limited opportunity for significant diversion of drainage flows between catchments and sub-catchments with the overall residual impact on flow regime categorised as local slight to imperceptible as only very minor land drains and recharge from the road pavement are potentially diverted.

The disturbance of field drainage systems represents a direct impact to the existing drainage regime. The drainage has been designed sympathetic to the natural drainage pathways maintaining where feasible existing drainage runs by culverting or slightly realigning the local drains across the proposed road development. The overall impact on surface drainage along the proposed road development is a slight to imperceptible residual impact.

No negative residual impacts on flood risk due to loss of conveyance are anticipated at the River Corrib and the various culverted watercourse crossings. All culvert design flows include large factors for uncertainty associated with flood estimation in small ungauged catchments and thus the proposed culvert sizes are conservatively large and in all cases substantially exceed the existing culvert sizes on such streams and therefore avoid any conveyance capacity issues. There will be no residual impact from the proposed road development.

The loss of floodplain storage where the proposed road development crosses such areas is minor relative to the catchment flood flows and existing flood storage volumes within the floodplain. The assessment identifies a slight reduction of flood storage at the River Corrib crossing adjacent to the Coolagh Lakes and at Ballindooley Lough both of which are considered to represent an imperceptible impact on flood risk and flow regime of the Coolagh Lakes and Ballindooley Lough.

The proposed flood mitigation measure for the N83 Tuam Road Junction to mitigate loss of flood storage from a pluvial flood risk area will provide a moderate to significant positive residual impact on flooding and flood risk at N83 Tuam Road Twomileditch area, as the proposed mitigation measure will reduce the flood risk to the existing road and to the six remaining houses.

However negative residual flood impacts associated with the N83 flood relief measures will remain:

- Discharge of flood water into the Terryland Basin at 250 l/s resulting in slight increase in flood levels within the Terryland River channel. The impact of this discharge on flood levels in the Terryland Basin is minor representing a slight permanent residual impact on flood levels
- Reduction of available capacity within the existing storm sewer located to immediately south in the City North Business Park (the full bore capacity in the pipe is estimated to be 900l/s and therefore the proposed maximum discharge of 250l/s will reduce the available capacity by 27% This is considered a slight impact
- Residual flood risk at the N83 Tuam Road associated with potential breakdown of the storm water pumping station, and blockage of storage area and associated drains and outfalls. This is considered slight in light of regular monthly inspections proposed

11.7.2 Water Quality

The proposed road drainage will be collected and discharged to watercourses resulting in localised water quality impact at the outfall sites. This impact is minimised by utilising best practice design using sustainable drainage systems (SuDS). These include filter drains and grassed surface water channels where permitted, vegetated lined wetlands, attenuation ponds and infiltration basins. The vegetated wetlands, are sized to cater for the potentially contaminated first flush volume 15mm effective rainfall. Further detention storage of runoff water, provided within the attenuation pond systems and infiltration basins, will permit further settlement of suspended pollutants. The impacts of reduction of water quality in streams receiving routine runoff is considered to represent slight and imperceptible permanent residual impacts.

All pollution control facilities and attenuation areas will be fitted with oil and petrol interceptor and a penstock or similar restriction at the outfall to the receiving channel and groundwater basin. The overall risk assessment to quantify the likelihood of a serious accidental spillage indicates a cumulative risk for the entire road length discharging to surface water courses as 0.07% which represents a very low risk of serious contamination. For most watercourse receptors, this potential spillage risk for individual outfalls is much smaller and therefore represents an imperceptible risk. The risk decreases westward along the route of the proposed road development.

The impact from an accidental spillage should it occur on all stream outfalls will be reduced using oil and petrol interceptors upstream of the ponds and outfall. A penstock control and spillage containment area which can be closed off in the event of a serious pollution incident arising will be provided for all mainline and new link road catchments. As a consequence of the design there will be an imperceptible residual impact from accidental spillages along the proposed road development.

The proposed road development discharges to the River Corrib near the bridge crossing a short distance 1.7m upstream of the Terryland Intake from the River Corrib at Jordan’s Island. 2.625km of proposed road development mainline and 0.625km of N59 Link Road North representing 7.1ha of road pavement area contributes to the proposed River Corrib outfalls at (S14A, S14B, S18A, S18B and S15) at the location of the intake. Routine road drainage discharges will have imperceptible impact on water quality of the Terryland Galway City water supply abstraction. A risk assessment of serious spillage for this section of the proposed road development indicated very low risk of spillage (0.042%). The provision of oil petrol interceptor, wetland treatment system and outflow control further reduces the risk of impact to the water supply to imperceptible.

11.7.3 Morphology

No significant local impacts to stream and river morphology are anticipated, as all practicable design measures for bridges, culverts, channel realignments and drainage outfalls are to be implemented which are designed to minimise the potential for local scouring and flow regime changes. The residual impact on river and stream channel morphology is classed as local slight permanent impact at the various culvert crossing and outfalls and classed as an imperceptible impact the

River Corrib crossing as there are no in-stream piers or in-stream works to be carried out.

11.7.4 Key Ecological Receptors

The key ecological receptors sensitive to surface hydrology impacts are Ballindooley Lough, Lough Corrib cSAC including the Coolagh Lakes and River Corrib channel, the various salmonid potential streams (including downstream reaches of the Bearna, Trusky and Knocknacarra Streams) and the coastal/transitional waters of the Galway Bay Complex cSAC. The key water dependent wetland receptors sensitive to surface hydrology include Blanket bogs, Transitional mires, Wet heath, Rich fen and flush, and Molinia Meadows.

The rating of these receptors varies from locally high for the watercourses and Ballindooley Lough and extremely high for the Lough Corrib cSAC including Coolagh Lakes and the River Corrib channel and Galway Bay Complex cSAC. The hydrological residual impact on these receptors is rated as imperceptible for the Coolagh Lakes, Ballindooley Lough and Galway Bay Complex cSAC.

The hydrological residual impact represents a slight local magnitude impact on the River Corrib channel. The impact is associated with the outfall discharges and the construction of two river bank drainage outfalls. There is a slight residual impact for the salmonid potential in local higher value streams associated with flooding, flow regime change, water quality and morphology changes all of which are localised and minor. The overall residual impact from the proposed road development and its drainage system on the Lough Corrib cSAC and Lough Corrib SPA is rated as an imperceptible residual impact. This rating is achieved through design of appropriate pollution control measures at the proposed road drainage outfalls and at appropriate design of the proposed bridge and culvert crossings.

The proposed road development and its drainage system will have an imperceptible residual hydrological impact on Galway Bay Complex cSAC and Inner Galway Bay SPA. This is achieved through design of appropriate pollution control measures at its road drainage outfalls.

Surface drainage impacts to water dependent wetland habitats have been identified where the proposed road development traverses through such a habitat or passes in close proximity upstream of such habitats. Overall the zone of influence (ZoI) on surface drainage by the proposed road development on these habitats does not exceed the hydrogeological ZOI. The exception to this is the potential impact to a downstream Wet Heath (4010) located 50m southeast of the proposed development boundary between Ch. 3+450 to Ch. 3+700 and Molinia Meadows (6410) located 30m east of the proposed development boundary at Ch. 3+800. In both cases, the proposed road development which is in a large cutting will intercept the local surface drainage partially supplying these wetlands and divert into the proposed road drainage to outfall elsewhere resulting in a potential reduction in the surface water supplying these wetlands. The hydrogeological ZOI from the proposed road development does not extend to these wetland features and therefore the groundwater table and flow is unlikely to be altered. The residual hydrological impact on these two wetland habitats represents moderate and slight permanent impact respectively.

11.7.5 Cumulative Impacts

Cumulative impacts are defined as the combination of many minor impacts creating one, larger, more significant impact (NRA, 2009 and EPA 2017). Cumulative impacts consider existing stresses on the natural environment as well as developments that are underway and in planning.

The baseline hydrology has identified that the surface water features in the study area have a number of existing stresses in the form of discharges from surface water drainage systems, road runoff and agricultural activities and loss of natural flood plains. These sources have the potential to impact the existing hydrological environment in the form of reducing water quality by increased contaminants or by increasing flood risk. On the basis that the design and mitigation measures employed for the proposed road development to maintain or improve water quality in existing catchments, there are no significant hydrological residual impacts associated with the proposed road development.

The Galway County Development Plan 2015-2021, Galway City Development Plan 2017-2023, Bearna Local Area Plan 2007-2017, Gaeltacht Local Area Plan 2008–2018 and Ardaun Local Area Plan 2018–2024 set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SUDS) and restricting surface water runoff discharge rates to meet that of greenfield runoff rates and volumes. Therefore, the residual impact associated with future proposed or planned developments on the hydrological environment is imperceptible.

The residual impacts associated with the following major projects and plans that are currently underway or in planning have also been assessed in more detail. These projects include:

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Proposed Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS)

The M17/M18 Tuam to Gort Motorway Project has recently completed construction. The portion of the M17 and Tuam Bypass (circa 26km) that lies north of the existing R339 Galway to Caltra Road, lies within the catchment of the River Corrib. The portion of the M17 M18 to the south of the R339 lies within the catchment of Galway Bay for the Oranmore River, Clarin River, Kilcolgan River, Gort River and Lough Coole turlough system. This M17/M18 scheme has been designed with a modern road drainage system and construction methods that reduce the potential impact on the receiving environment. Where residual local impacts arise at various road outfalls, culvert crossings and displacement of flood storage, the impacts do not translate downstream in the River Corrib or to Galway Bay as perceptible impacts that would combine with residual impacts from the proposed road development, given the very large dilution available and the travel distances involved.

There will be no perceptible hydrological cumulative impact between the M17/M18 Tuam to Gort Motorway Scheme and the proposed road development.

The N59 Oughterard to Maam Cross Road Scheme and N59 Moycullen Road Scheme also lie within the catchment of the River Corrib upstream of the proposed road development. Both N59 road schemes have been designed with modern road drainage systems and construction methods that reduce the potential impact on the receiving environment. Where local impacts arise at various road outfalls and culvert crossings and displacement of flood storage and changes to river and stream morphology, these impacts do not translate downstream in the River Corrib (given the very large dilution available and the travel distances involved) as perceptible impacts that would combine with residual impacts from the proposed road development. There will be no perceptible hydrological cumulative impact between the N59 Oughterard to Maam Cross Road Scheme and the N59 Moycullen Road Scheme with the proposed road development.

The proposed Galway Harbour Expansion Project is located in the Galway City Coastal catchment and at the mouth of the River Corrib Estuary downstream of the proposed road development. The following hydrological residual impacts have been extracted from the summary of residual impacts from the Galway Harbour Company, Galway Harbour Extension Environmental Impact Statement:

- *Alteration of salinity levels in vicinity of the River Corrib outflow during construction as a result of increased current velocities or changes in current direction due to the construction of the proposed development – Permanent Slight Positive Impact*
- *Alteration to current velocities at the proposed development site will impact the sedimentary environment resulting in a shift of existing scouring and deposition sites and subsequent alteration of benthic habitat resulting from construction of the proposed development in the intertidal and subtidal zone in proximity to the River Corrib outflow – Permanent Slight Negative Impact*
- *Alteration to current directions at the proposed development site will impact the sedimentary environment resulting in a shift of existing scouring and deposition sites and a subsequent alteration of benthic habitat types as a result of construction of proposed development in the intertidal and subtidal zone in proximity to the River Corrib outflow – Permanent Imperceptible Impact*
- *Release of grey water from construction site as a result of construction activities – Temporary Slight Negative Impact*
- *Release of sewage from construction site resulting from leakage from construction site and vessels – Temporary Slight Negative*

- *Release of diesel from construction site resulting from leakage from construction site – Temporary Slight Negative*
- *Oil Spills and other accidental release of fluids/solids during loading/off-loading of vessels as a result of accidental spillage – Temporary High Negative Impact*
- *Impacts from maintenance dredging as a result of sedimentation and smothering arising from dredging and disposal – Short Term Serial Localised Negative Impacts*
- *Changes in wave climate as a result of increases and decreases due to new structure – Permanent Low Impact*

The proposed road development will have no noticeable effect on the flow regime, salinity, sedimentation process or water quality downstream in the River Corrib Estuary and Inner Galway Bay, both during construction and operation stages. Therefore, no cumulative hydrological impacts will occur between the Galway Harbour Expansion project and the proposed road development, even if the construction phases for both projects were to coincide.

There are a number of elements of the Galway Transport Strategy (GTS) located within the same hydrological catchments as the proposed road development.

The relevant elements of the Galway Transport Strategy that could have an impact on hydrology include:

- the upgrading of pedestrian network
- the upgrading of cycle network which includes the Bearna Greenway, the Galway to Dublin Cycleway (Galway City to Oranmore)[1], the Galway to Oughterard Greenway[2] and non-greenway elements
- Expansion of Public Bike Hire Scheme (currently under construction)
- The upgrading of public transport network including increased frequency of buses and a new cross city access link (including the N83 Tuam Bus Corridor Scheme)
- the upgrading of road network which includes modifications to the existing road infrastructure and the proposed road development

The GTS is at the plan stage so each individual project element of the design will be subject to further detail design. The detailed design shall be in compliance with the surface water management and water quality objectives set out in the various development plans. Therefore, there should be no cumulative impacts associated with this development.

[1] The GTS includes that portion of the Galway to Dublin Cycleway between Galway City and Oranmore.
[2] The GTS includes that portion of the Galway to Oughterard Greenway between Galway City and Moycullen.

11.8 Summary

The proposed road development, passes through three hydrometric areas 29 - Galway Bay South East, 30 - Corrib and 31 - Galway Bay North along its 17.4km length. Within the study area there are two distinct regions of hydrological response, with the area to the west of the N59 Moycullen Road associated with the granite bedrock having high surface run-off characteristics and the area to the east of the N59 Moycullen Road having low surface run-off associated with karst permeable limestone bedrock. This results in a reasonably dense network of surface drains in the western section and a very sparse non-existent surface drain network in the eastern section. Consequently, the drainage solution for the proposed road development is challenging in the eastern section requiring infiltration to groundwater for safe disposal of road drainage waters.

The proposed road development traverses only one major watercourse, namely the River Corrib which is of international importance being part of the Lough Corrib cSAC and Lough Corrib SPA. The remaining watercourses encountered, principally to the west are minor, the majority of which are intersected close to their upstream watersheds. Therefore, these watercourses have limited contributing catchment areas, and consequently are of low capacity. They are poorly established stream channels and generally not maintained. The attribute rating of these small watercourses, which include the Trusky Stream, Bearna Stream and Knocknacarra Stream is one of local higher and of fishery interest/potential in their downstream reaches closer to the coast. Other watercourses/drains encountered are of limited fisheries importance but are also classified as local higher ecological value which include the Sruthán na Libertí.

The proposed road development will involve 17 culvert crossings and one major bridge crossing. All of the 17 culvert crossings are crossing small watercourses, with the largest catchment being less than 5 km², which is the Bearna Stream. A number of local diversion and realignments are associated with the various culvert crossings so as to facilitate channel transition to and from the new culverts. These have a potential for constructional impact and more permanent local morphological changes. A realignment is proposed for the Tonabrocky Stream to facilitate the proposed road development and to avoid a significant length of culvert beneath the proposed road development. Mitigation for this realignment is to incorporate fish friendly design incorporating shoals, pools and meanders.

The drainage system for the proposed road development will include 54 road drainage outfalls, which comprise the following:

- 25 to surface watercourses at new storm outfalls
- 9 to groundwater via new infiltration basins
- 17 to existing public surface water sewers
- 2 (tunnel sections) to be pumped to the public foul sewer
- 1 to an existing N6 road infiltration basin

The proposed surface water outfalls and culvert crossings represent a potential for local flood impact, morphological changes and water quality impacts both during construction and operation phases. This is described further below.

The major bridge crossing of the River Corrib from Dangan to Menlough is designed to clear span the main river channel and provide as a minimum 5m setback from the river edge for its two banksides piers. The clear spanning of River Corrib avoids the need for in-stream works at the construction stage which lessens the potential for constructional and operational (permanent piers) impacts. The River Corrib is the source to a major public drinking water abstraction that supplies Galway City, located downstream at Terryland, off Jordan's Island. The abstraction point is only 1.7km downstream of the proposed road development. There is therefore, a high pollution risk (in the absence of mitigation measures) from the proposed road development to water quality, particularly during the construction phase.

Stringent mitigation and control of potential polluting activities associated with construction activities is proposed which will significantly reduce this pollution risk. Stringent controls are proposed to limit the risk of untreated sediment run-off entering the water body and to minimise the risk of construction spillages of concrete and hydrocarbons into these waters. Refer to the CEMP in **Appendix A.7.5**. Specifically, there will be no in-stream works at the River Corrib channel associated with the construction of the river bridge crossing that fully spans the River Corrib channel, so as to protect both the Lough Corrib cSAC and SPA and the major downstream drinking water abstraction to the Galway City Water Treatment Plant at Terryland.

The operational phase also presents a pollution risk to the Terryland water supply both from accidental spillages and from routine road run-off discharges. However, design pollution control measures have been put in place to significantly reduce the risk.

In conclusion, residual construction and operational pollution impacts on the River Corrib will be slight to imperceptible. Elsewhere, construction impacts on water quality are reduced from having potentially moderate and significant temporary impacts to having slight and imperceptible temporary impacts through mitigation with the implementation of the CEMP in **Appendix A.7.5**.

During the operational phase, water quality in the receiving streams (which have been identified as of generally good quality status) will be protected from proposed road drainage discharges. Oil and petrol interceptors along with wetland treatment systems will be placed upstream of all surface water outfalls and groundwater infiltration basins. These are designed to capture first flush rainfall events and provide protection against both minor or large road spillages. An operational spillage assessment for the proposed road development was carried out for all outfalls, both surface and groundwater, and the results show low risk of impact from serious accidental spillage involving a HGV. In conclusion, residual water quality impacts on these watercourses will be slight during the operational phase.

The proposed road development passes close to the Coolagh Lakes and Ballindooley Lough. There is only a very slight encroachment by the proposed road embankment of the extreme floodplain area of these lakes and there will be no direct surface water discharge to the Coolagh Lakes. There is a single small treated surface discharge from the N84 Headford Road to Ballindooley Lough. The overall hydrological impact on these features is rated as slight to imperceptible with the construction phase representing the greater risk to the lakes. Similar to other sensitive aquatic locations, such as the River Corrib crossing, stringent mitigation and control of potential polluting activities associated with construction activities is proposed which will significantly reduce the risk of impact to a slight temporary impact.

The proposed road development as part of the EIAR has undergone a detailed Flood Risk Assessment in accordance with the DoEHLG Planning System and Flood Risk Management Guidelines for Planning Authorities. The assessment identified the sources of flood risk to the proposed road development from fluvial, pluvial and groundwater sources, but not from a coastal source as the proposed road development is sufficiently set back and elevated above the coastal zone. Overall the assessment has concluded that the proposed road development design minimises flood risk to the development itself and is rated as having a low probability of flooding.

A potential significant flood risk impact has been identified in the vicinity of the N83 Tuam Road Junction resulting in the permanent encroachment and loss of flood storage from this flood risk area. Flood relief mitigation measures involving improved land and road drainage, provision of compensation storage and storm water pumping to the Terryland Basin have been designed which when implemented will result in providing a residual moderate to significant positive benefit by reducing the risk of serious flooding in this area.

At all other locations along the proposed road development, there will only be slight to imperceptible impacts on flood risk as very minimal encroachment of floodplains occur and design measures in the form of large culverts and stormwater attenuation ponds are proposed. Residual flood risks exist at the drainage outfalls and their associated attenuation ponds and at the various culverts from potential blockages. This impact through the design of the proposed road development has been assessed as a slight residual flood risk achieved by the proposed program of regular inspections and maintenance of these assets and for the ponds the inclusion of controlled overflow systems in the event of a blockage. The culverts are all generously sized and blockage potential is minimised.

The proposed road development satisfies the requirements of the Water Framework Directive in terms of maintain, protecting and enhancing the water quality status of the receiving watercourses and groundwater. Protection is achieved through the provision of storm water treatment and controlled discharge at the proposed road drainage outfalls and enhancement is achieved by taking road traffic from unprotected roads where uncontrolled road runoff enters adjacent watercourses and the groundwater aquifers.

Potential hydrological impacts from the proposed road development have been identified and assessed. Appropriate design and mitigation measures have been incorporated to remove any risk of significant hydrological impact on the receiving environment. There are no significant negative residual hydrological effects due to the proposed road development.

The overall residual hydrological impact from the proposed road development on the Lough Corrib cSAC and SPA and the Galway Bay Complex cSAC and Inner Galway Bay SPA is rated as imperceptible. This is achieved through design of appropriate pollution control measures at the proposed road drainage outfalls, the proposed full spanning bridge structure of the River Corrib channel and effective floodplain area and the proposed implementation of the CEMP during construction. Refer to **Appendix A.7.5**.

There are no significant cumulative hydrological impacts associated with this proposed road development in combination with other projects either granted or in planning.

11.9 References

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12 Landscape and Visual

12.1 Introduction

This chapter of the EIAR consists of an appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, under the heading of landscape and visual aspects.

This chapter initially sets out the methodology followed in carrying out the appraisal (**Section 12.2**), describes the existing landscape and visual environment (**Section 12.3**), and summarises the main characteristics of the proposed road development that are of relevance to landscape and visual aspects (**Section 12.4**). The evaluation of impacts of the proposed road development on the landscape and visual environment are described (**Section 12.5**), measures are proposed to mitigate these impacts (**Section 12.6**), and residual impacts are described (**Section 12.7**). The chapter concludes with a summary (**Section 12.8**) and reference section (**Section 12.9**).

This chapter has utilised the information gathered during the constraints and route selections studies for the proposed road development to inform the landscape and visual impact appraisal. **Sections 4.7**, **6.5.5** and **7.6.5** of the **Route Selection Report** considered the landscape and visual constraints within the scheme study area and compared the potential landscape and visual impacts of the proposed route corridors respectively. These assessments and sections of the Route Selection Report contributed to the design of the proposed road development which this chapter assesses.

12.2 Methodology

12.2.1 Introduction

Landscape has two separate but closely related aspects. The first is **visual impact**, *i.e.* the extent to which new development can be seen in the landscape. The second is **impact on landscape character**, *i.e.* effects of new development on the fabric or structure of the landscape.

The visual impact assessment considers visual receptors along the proposed road development. The majority of receptors involve residential properties, however, cultural and heritage properties, community facilities, *e.g.* churches, amenities and recreational facilities, open spaces, walkways, and other viewers within the environment are also considered.

Landscape character is derived from the appearance of the land, and takes account of natural and man-made features such as topography, landform, vegetation, land uses and built environment and their interaction to create specific patterns that are distinctive to particular localities. Therefore, aspects such as landscape character and landscape designations are also considered in the description of the receiving landscape.

12.2.2 Legislation and Guidelines

The methodology has regard to Sections 50(2) and 50(3) of the Roads Act 1993 as amended, and the following guidance publications:

- EPA: Guidelines on the Information to be contained in Environmental Impact Statements, 2002
- EPA: Advice Notes on Current Practice (in the preparation of Environmental Impact Statements) 2003
- EPA: Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports, 2017
- EPA: Draft Advice Notes for Preparing Environmental Impact Statements, Consultation 2015
- LI/IEMA: Guidelines for Landscape and Visual Impact Assessment, 3rd Edition, 2013
- NRA: Environmental Impact Assessment of National Road Schemes - A Practical Guide
- NRA: A Guide to Landscape Treatments for National Road Schemes in Ireland
- NRA: Guidelines on the Implementation of Landscape Treatments on National Road Schemes in Ireland
- NRA: Guidelines for Protection and Preservation of Trees, Hedgerows and Scrub Prior to, during and Post Construction of National Road Schemes
- NRA: Design Manual for Roads and Bridges

12.2.3 Data Sources and Consultations

The findings and recommendations of other chapters of this EIAR have also been considered in the preparation of this assessment. Particular liaison and consultation has taken place with the relevant specialists in the project team in terms of the design for the proposed road development and with particular respect to aspects such as Archaeological, Architectural and Cultural Heritage, Biodiversity, Noise and Vibration, Human Beings and Construction Activities.

12.2.4 Scheme Study area and Baseline Data Collection

The landscape setting for the proposed road development covers a wide corridor comprising a part rural, part peri-urban and part suburban landscape extending from west of Bearna Village around the north and east of Galway City to a tie-in with the existing N6 between Dougishka and Coolagh-Briarhill.

Baseline data collection involved reviewing desktop information including statutory planning documents, landscape character assessments and other landscape and visual related publications and sources in order to identify likely significant and sensitive landscape and visual receptors. The findings of the desktop data collection stage was augmented, refined and verified during a series of survey visits, undertaken at different times during the year, to the landscape corridor of the proposed road development. This allowed for identification of visual receptors, landscape features, vegetation, and for analysis of local landscape and visual character.

12.2.5 Impact Assessment Methodology

The significance criteria as set out in the EPA Guidelines have been used for the purpose of this assessment, see **Table 12.1** Landscape and Visual Impact Assessment Criteria. The criteria have been modified to take account of the current Draft EPA Guidelines (2017) and other references used in the assessment methodology.

The significance of landscapes is considered against their designation (*i.e.* national, county, local, *etc*.). Where not designated or otherwise protected, landscapes are considered as being of local significance. Therefore, landscape assessments take account of the receiving environment, its character and features, as well as landscape planning designations and listings.

Views from properties are all considered on an equal basis without varying degrees of significance or sensitivity. All properties located within 200m of the centreline of the proposed road development are considered, together with any property outside of 200m, which for reasons of openness, or otherwise, are considered to have potential for significant impact. For the most part, properties outside 200m of the centreline of the proposed road development that have no potential for impact have not been included in the assessment. While these properties may have sight of the proposed road development, due to a combination of distance, context, elevation or intervening topography, the proposed road development comprises a small element of the overall panorama and will not give rise to an adverse impact. Visual impact from properties other than residences is also considered and as such, schools, community facilities and recreational and other amenities are also included.

Visual assessments for properties are tabulated in the Visual Impact Schedule (VIS) Tables in **Appendix A.12.1** and are illustrated on the Landscape and Visual figures (Refer to **Figures 12.1.01** to **12.1.14**). The properties are numbered using sequential chainage-based references in approximate geographical order from west to east along the proposed road development.

Visual impacts are assessed at three key stages:

Construction Stage: considers the period of active construction of the proposed road development up to completion of the works.

Pre-establishment Stage: considers the period of initial operation of the proposed road development where new landscape measures are unlikely to provide effective mitigation. All works, including new boundaries, barriers, screens, seeding, *etc*. are complete and while planting will be in place, it would require a period of time to establish as effective mitigation. The impact is assessed in the year the proposed road development would open to traffic.

Post-establishment Stage: considers the impact after such time as proposed planting has established and is providing effective landscape and visual mitigation.

This usually requires a period of five to seven years after planting. The impact is assessed c.15 years after the proposed road development would open to traffic.

Table 12.1: Classification of Significance of Impacts

		Existing Environment Significance / Sensitivity			
		High	**Medium**	**Low**	**Negligible**
Description of Impact Character / Magnitude / Duration / Probability/ Consequences	**High**	Profound	Very Significant	Significant / Moderate	Moderate / Slight
	Medium	Very Significant / Significant	Significant / Moderate	Moderate	Slight / Not Significant
	Low	Significant / Moderate	Moderate / Slight	Slight / Not Significant	Not Significant / Imperceptible
	Negligible	Slight / Not Significant	Not Significant	Not Significant / Imperceptible	Imperceptible

These impacts[1], which in quality may be positive, neutral or negative/adverse, are described as follows:

- **Imperceptible:** An effect capable of measurement but without noticeable consequences
- **Not significant:** An effect which causes noticeable changes in the character of the environment but without noticeable consequences
- **Slight:** An effect which causes noticeable changes in the character of the environment without affecting its sensitivities
- **Moderate:** An effect that alters the character of the environment in a manner that is consistent with existing and emerging trends
- **Significant:** An effect which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment
- **Very Significant:** An effect which, by its character, magnitude, duration or intensity significantly alters the majority of a sensitive aspect of the environment
- **Profound:** An effect which obliterates sensitive characteristics

In terms of **duration**, effects are considered as follows:

- **Brief:** lasting up to one day
- **Temporary:** lasting up to one year
- **Short-term:** lasting one to seven years
- **Medium-term:** lasting seven to fifteen years

1 It should be noted that throughout this chapter of the EIAR, the terms impact and effect are interchangeable and should be read to have the same meaning.

- **Long-term:** lasting fifteen to sixty years
- **Permanent:** lasting over sixty years

Further aspects including do-nothing, worse-case, cumulative, interactive, indirect and residual impacts are also considered, where appropriate, in the assessment.

12.3 Receiving Environment

12.3.1 Landscape Context and Character

12.3.1.1 General

Galway City is situated on the River Corrib, a short c.6km river linking Lough Corrib in the north to Galway Bay in the south. The historic city and the city core is centred on the southern extent (mouth) of the river but the city has also extended significantly both eastwards towards Oranmore and westwards towards Bearna. While city expansion to the north has been constrained by Lough Corrib, development has extended along the corridors of the various national, regional and local roads that radiate out west, northwest, northeast and east from the city centre.

The landscape along the proposed road development is divided into two distinct sections by the River Corrib at Dangan/Menlough. The west side of the river valley (along the existing N59 Moycullen Road) is also the boundary of a clear geographical divide between the underlying granite geology to the west and limestone to the east.

In general, the landscape to the west of the river is characterised by a pattern of irregular shaped, undulating enclosed fields delineated by drystone granite walls. Stretches of Blanket bog are also common and many fields, particularly in the vicinity of Bearna, are increasingly overgrown with scrub and bramble.

The landscape to the east is characterised by a pattern of larger, usually rectangular fields of improved grassland. The notable exceptions to this are the overgrown and wooded demesne landscape of Menlo Castle, the areas of bare Limestone pavement with surrounding dense hazel scrub, and the presence of large limestone quarries at Coolough (Lackagh Quarry) and at Ballygarraun/Pollkeen (Roadstone Quarry, off the N83 at Twomileditch).

The landscape within the city and north along the wider River Corrib corridor is low-lying typically being lower than 30m above ordnance datum (OD). Within the extended city, the landscape rises gradually to the east to circa 70m OD at Briarhill (Dougishka) where the local high point is topped by a reservoir. To the west of the N6/Bóthar na dTreabh, Dougishka includes established residential estates (Garrán Ard, Maigh Rua, Garran Íseal, Sraith Fhada, An Sean Bhaile) – many of which openly overlook the existing N6/Bóthar na dTreabh. To the east the landscape is open, rural and increasingly flat with limestone walls. The village of Coolagh-Briarhill lies to the immediate north of the existing N6 approach to the city.

To the northeast, the landscape undulates over shallow valleys and low ridges towards Lough Corrib. The ridges at Ballygarraun/Pollkeen and

Ballindooley/Coolough are topped with limestone quarries and exposed limestone pavement and limestone walls are also a feature of the wider area from Ballindooley through to Menlough. Much of this area is covered with hazel scrub with limited tree cover. The villages of Castlegar and Coolough-Menlough retain a distinctive village character despite the increasing expansion of the city into their immediate context.

The ruin of Menlo Castle and its associated grounds provide an attractive landmark feature on the east side of the river close to where it leaves Lough Corrib. Menlough Village, also located on the east bank of the river, has an attractive and historic network of narrow rural roads with a dense network of individual and clustered residential properties.

North of the city the River Corrib forms a broad and attractive watercourse set within a landscape mosaic of grassland and marginal grassland, sports areas (*e.g.* National University of Galway (NUIG) Sports Campus and Glenlo Abbey Golf Course) and areas of wetland/marsh (especially at the northern reaches of the river approaching Lough Corrib) scrub and woodland plantings. The entire valley is low-lying and the immediate river valley is below 10m OD.

West of the River Corrib, the landscape rises to the northwest of the city where a local high point at Tonabrocky (111m OD) is marked with telecommunication masts. From Tonabrocky the landscape falls gradually south and southwest to the coastal corridor extending either side of Bearna Village.

A large lake, Lough Inch, is located circa 1.5km northwest of Bearna Village. Large areas of bogs/peatlands are located west/northwest of Bearna, including around Lough Inch and at Tonabrocky Bog further north.

Extensive residential development is a particular feature along the R336 Coast Road and along other local roads in the wider area around Bearna Village.

Extensive residential, community and mixed developments is also a feature along the N59 Moycullen Road corridor extending northwest from the city. This includes developments such as Dangan Business Park, the NUIG Sports Campus and the hotel and golf course resort at Glenlo Abbey.

12.3.1.2 Landscape along Proposed Road Development

The overall length of the proposed road development is c.17.54km and includes for other new and re-aligned link roads and realigned sections of existing roads, as well as for over 2.2km of N59 Link Road from Bushypark on the existing N9 Moycullen Road in the north, to the Rahoon Road in the south. Refer to **Chapter 5, Description of Proposed Road Development** for further details.

The route of the proposed road development skirts the peri-urban landscape that lies between the developed western, northern and eastern suburbs of the city and the surrounding rural hinterland. Many sections of the route of the proposed road development are overgrown with blackthorn, gorse and hazel scrub and bramble.

The landscape along the initial western section of the proposed road development is a rugged lowland landscape of small fields, marginal grassland, extensive and increasing areas of scrub, granite stone walls in a variety of condition, and residential development prominently located along the main and local roads throughout.

To the northwest the route of the proposed road development passes through Cappagh, Mincloon, Letteragh and Barnacranny on the exposed lower southern slopes of ground that rises gradually towards Tonabrocky Hill.

To the north of the city, the route of the proposed road development leaves high ground at Dangan, which includes extensive residential and recreational/sports development, and crosses the wide lowland valley of the River Corrib before moving onto gradually rising ground east of Menlo Castle. The ivy-covered castle ruin, located north of the proposed crossing location is a prominent landmark feature along the river corridor.

To the northeast the route of the proposed road development crosses the rolling drumlin and valley landscape between Coolough (and Lackagh Quarry), Ballinfoile and Castlegar. The route passes immediately south of Ballindooley Lough and through a residential area at Castlegar. The route is north of the defined settlement area of Castlegar Village, as identified on the Land Use Zoning and Specific Objectives Map of Galway City Development Plan 2017-2023. Residential development is a prominent feature in the existing landscape both where the proposed road development crosses the N84 Headford Road at Ballindooley and passes through Castlegar.

To the east of the city, the route of the proposed road development passes to the immediate east of Galway Racecourse before turning south and east around the village of Coolagh-Briarhill to tie-in to the existing N6 and the R446 Bother na dTreabh south of the village and east of Dougishka.

The main landscape features along the proposed road development include the diversity of ecological/landscape and cultural areas, the mosaic of open grassland, limestone pavement, marsh, wetland, river corridor/lake edge, scrub/and occasional tree plantings; the presence of significant recreational and sports grounds (including Galway Racecourse and NUIG Sports Campus) and other open spaces; and the overall high quality of the landscape – especially along the River Corrib corridor and east through to Ballindooley. These features add to overall diversity and interest of the landscape as well as to its sensitivity and significance.

As noted while there are extensive areas of scrub, including gorse and blackthorn to the west and hazel and blackthorn to the northeast, the plantings are generally low and the landscape is often visually open and tree and woodland planting is notably limited along the proposed road development. The presence of mature trees and blocks of trees is most notable within the River Corrib valley, including around residential and sports facilities on the west bank of the river and on rising ground east of Menlo Castle on the east bank.

Given the city edge location, the presence of residential properties is a notable and prominent visual feature along the entirety of the route of the proposed road development. In addition, there are a variety of community and social amenities as well as rural villages located close to the proposed road development. Visual significance also applies to features of archaeological, architectural and cultural heritage, *e.g.* Menlo Castle, Bushypark House, *etc*., as described under **Chapter 13, Archaeological, Architectural and Cultural Heritage**.

12.3.1.3 Landscape Character Assessment

The Landscape and Landscape Character Assessment for County Galway[2] (2003) sub-divides the county into 25 large landscape character areas (LCAs). Landscape values and sensitivity ratings have also been applied to each of the LCAs. Only five of the LCAs (3, 5, 9, 11 & 12) pertain to the route of the proposed road development (refer to **Plate 12.1** and **Table 12.2**).

The western portion of the proposed road development is located within:

- Landscape Character Area 9: *Inverin to Galway City Coastline, which covers the southwestern portion of the study area in and around Bearna and City Coastline*

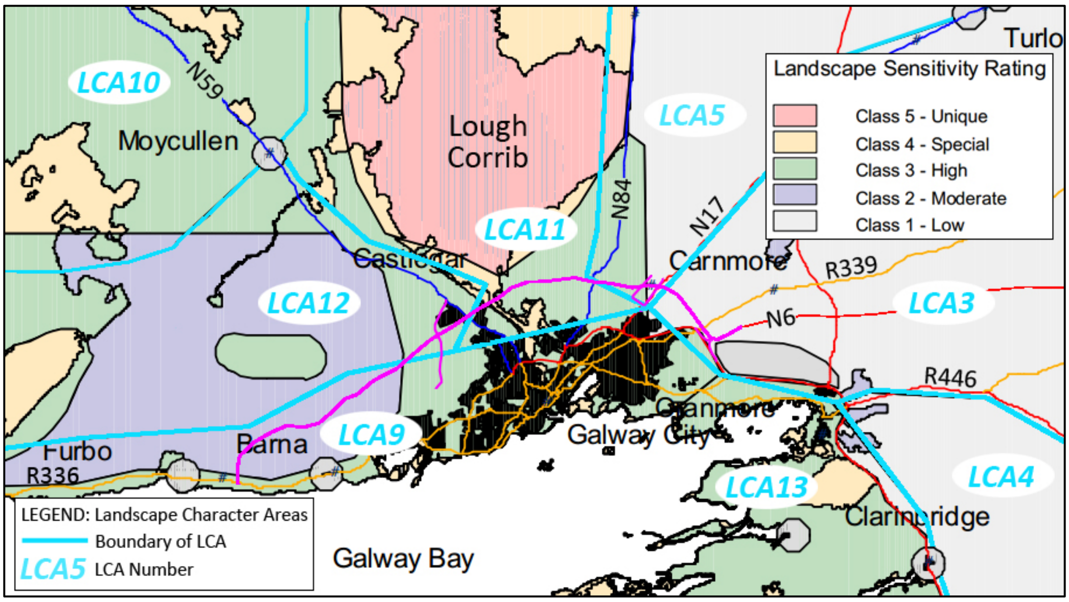
Thereafter continuing clockwise, the proposed route development passes through the edge of the following LCAs:

- LCA 12: *South foothills of east Connemara Mountains (west of Salthill to Rossaveel)*
- LCA 11: *Lough Corrib and environs*
- LCA 5: *Northeast Galway (Tuam environs)*
- LCA 3: *East Central Galway (Athenry, Ballinasloe to Portumna)*

The Lough Corrib LCA (11), which covers the central section of the proposed road development (north of the city), is the most sensitive, being described as '*wide dramatic expanse of water including many islands supporting deciduous woodland. The land … surrounding the southern section is flat, open grassland. The landscape of the Lough and its surrounds is highly scenic and includes many facilities for visitors*.' (Section 2.13 of Landscape and Landscape Character Assessment for County Galway).

[2] Included as Environmental Support Document to Galway County Development Plan 2015-2021 (http://www.galway.ie/en/services/planning/developmentplansandpolicy/galwaycountydevelopmentplan2015-2021/)

Plate 12.1: LCAs and Sensitivity Ratings with proposed road development indicated in Pink *(source: Extract of Figure 3 of Landscape and Landscape Character Assessment of Galway County – annotated to show LCAs, LCA Numbers and alignment of proposed road development (indicated in pink))*



Each of these county-wide LCAs represents a broad landscape area, and as such in the course of carrying out this assessment, the landscape along the route of the proposed road development has been further sub-divided into Local Landscape Character Units (LLCUs), which highlight more immediate and distinctive landscapes characteristics. The LLCUs are described in **Table 12.2** and illustrated on **Figures 12.2.01** and **12.2.02** Landscape Character.

While somewhat distant from the immediate line of the proposed road development, both Lough Corrib and Galway Bay are considered waters of national tourism significance[3].

[3] Determination of Waters of National Tourism Significance and Associated Water Quality Status, Fáilte Ireland (2009)

Table 12.2: Landscape Character Areas (LCAs) and Local Landscape Character Units (LLCUs)

LCA, Approx. Chainage & Length	Landscape Character Area (LCA) Description, Value and Sensitivity	Local Landscape Character Units (LLCU)	LLCU Landscape Description, Value and Sensitivity
LCA 9 Ch. 0+000 to Ch. 7+200 (c.7.2km)	**Inverin to Galway City Coastline:** The coast is flat, comprising rocks and sand merging with natural grassland, towards the R336. The coast line commands striking views of County Clare and the Aran Islands. Further inland from the R336 route, there are residential and some light industrial developments which have lowered the scenic value in this area. **High Landscape Value and High Landscape Sensitivity with parallel strip of Special Sensitivity**.	**Coastal Fringe – Bearna:** Ch. 0+000 to Ch. 0+250 (c.0.25km)	Open grassland with sea views and granite stone walls. Increasingly coarse-grained marginal grassland with extensive scrub north of the R336. **Moderate Value and High Sensitivity north of R336. High Value and Special Sensitivity south of R336**.
		Undulating Western Lowlands: Ch. 0+250 to Ch. 6+300 (c.6.05km)	Marginal coarse grassland/peatland with extensive scrub and overgrown granite stone walls. **Moderate Value and Moderate Sensitivity**.
LCA 12 Ch. 7+200 to Ch. 7+700 (c.0.5km)	**South foothills of east Connemara Mountains:** The landscape of the foothills is undulating heath and scrubland with regular rocky outcrops. The area is generally undeveloped and have expansive views in a southerly direction across Galway Bay towards County Clare. **Medium Landscape Value and approximately half High Landscape Sensitivity and half Special Sensitivity**.	**Open Western Uplands:** Ch. 6+300 to Ch. 8+000 (c.1.7km)	Increasingly open and elevated landscape on rising slopes. Some granite stone walls and limited hedgerows. **High Value and High Sensitivity**.
LCA 11 Ch. 7+700 to Ch. 13+100 (c.5.4km)	**Lough Corrib and Environs:** Lough Corrib is a wide, dramatic expanse of water including many islands supporting deciduous woodland. The land around the northern part of the Lough is undulating heath bog and coniferous forestry whereas the land surrounding the southern section	**West Galway Suburbs:** Ch. 8+000 to Ch. 8+800 (c.0.8km)	Elevated lands dominated by residential (and some other) development. **Moderate Value and Moderate Sensitivity**.
		Institutional City Lands: Ch. 8+800 to Ch. 9+100 (c.0.3km)	Amenity, recreational and sports-related lands – with open public access.

LCA, Approx. Chainage & Length	Landscape Character Area (LCA) Description, Value and Sensitivity	Local Landscape Character Units (LLCU)	LLCU Landscape Description, Value and Sensitivity
	is flat, open grassland. The landscape of the Lough and its surrounds is highly scenic and includes many facilities for visitors. **Outstanding Landscape Value and Unique Landscape Sensitivity with pockets of High and Special Sensitivity**.		**High Value and Special Sensitivity.**
		Corrib River Valley: Ch. 9+100 to Ch. 9+900 (c.0.8km)	Broad lowland river with large expanse of slow-moving water fringed by mosaic of wetland, amenity, grassland and woodland landscapes. Accentuated by presence of significant castle ruin. **High Value and Unique Sensitivity**.
		Limestone Lowlands: Ch. 9+900 to Ch. 11+200 (c.1.3km)	Scrub dominated areas of limestone pavement, grassland and stone walls. **High Value and Special Sensitivity**.
LCA 5 Ch.13+100 to Ch.14+200 (1.1km)	**Northeast Galway:** Landscape is flat, fertile pastoral land bound with field hedgerows. There is little or no coniferous forestry or deciduous woodland. There are no areas of particular scenic value. **Low Landscape Value and Low Landscape Sensitivity with pockets of Moderate Sensitivity**.	**Undulating Limestone Lowlands:** Ch. 11+200 to Ch. 14+100 (c.2.9km)	Prominent rolling drumlin ridges and valley grassland landscape with hedgerows. Large limestone rock quarries on open ridges and lough with surrounding wetlands in valley. **High Value and High Sensitivity**.
LCA 3 Ch.14+200 to Ch.17+540 (3.34km)	**East Central Galway:** The landscape is flat, coarse grassland, occasional clumps of coniferous forestry between 1–3km^2 in size, fields defined principally by stone walls. There are no areas of particular scenic value although the stone walls are quite distinct.	**East Galway Suburbs:** Ch. 14+100 to Ch. 14+500 (c.0.4km) & Ch. 15+400 to Ch. 16+000 (c.0.6km)	Lands dominated by residential and business park development. **Moderate Value and Moderate Sensitivity**.
		Galway Racecourse: Ch. 14+500 to Ch. 15+400 (c.0.9km)	Flat open landscape and significant city and region amenity. **High Value and Special Sensitivity**.

LCA, Approx. Chainage & Length	Landscape Character Area (LCA) Description, Value and Sensitivity	Local Landscape Character Units (LLCU)	LLCU Landscape Description, Value and Sensitivity
	Low Landscape Value and Low Landscape Sensitivity with pockets of Moderate Sensitivity.	**Open Limestone Lowlands:** Ch. 16+000 to Ch. 17+540 (c.1.54km).	Increasingly flat open grassland landscape with limestone walls and occasional mature trees. **High Value and Moderate Sensitivity**.

12.3.1.4 Galway City Development Plan 2017-2023

The provision of the proposed road development is an integrated part of the Galway Transport Strategy (GTS). The GTS, and hence the proposed road development has been incorporated into both Galway City Development Plan 2017-2023 and Galway County Development Plan 2015-2021 as varied.

The provision of the proposed road development as part of the integrated GTS is a stated objective of Galway City Development Plan. This objective is supported in particular by Policies 3.3, 3.4, and 3.7 as well as by the Specific Objectives outlined under Section 3.10 of the Plan. The corridor of the proposed road development is also expressed on the Land Use Zoning and Specific Objectives Map of Galway City Development Plan and described as 'N6 Galway City Ring Road (N6 GCRR)'.

In terms of land use zoning in the Galway City Development Plan it is stated that the '*strategic objectives which include the plan commitments to preserve the N6GCRR Preferred Route Corridor and the associated land requirements will take priority over other land uses and objectives.*' (page 14, Galway City Development Plan 2017-2023).

In terms of landscape and visual considerations, Chapter 2 of the Galway City Development Plan addresses **Housing and Sustainable Neighbourhoods** and sets out various policies and specific objectives to develop, enhance, protect and regenerate existing and proposed residential areas, including those within the outer suburbs (Section 2.5) and established suburbs (Section 2.6). Section 2.10 of Galway City Development Plan addresses **Village Envelopes/Areas**, and recognises four village settlement areas with distinct characters within the Plan area. These are Menlough, Castlegar, Coolagh-Briarhill and Coolagh-Menlough as shown on **Figures 12.3.01** and **12.3.02**. Policy 2.10 seeks to strengthen the character of these villages and to protect and enhance their amenity and identity.

Chapter 4 of Galway City Development Plan sets out the policies and objectives in relation to **Natural Heritage, Recreation and Amenity**. This Plan identifies the green network of the city and the spaces that comprise this network (refer to Table 4.1 of Plan and to **Plate 12.2** of this chapter of the EIAR). The network is promoted and supported by Policy 4.1.

The network includes **protected spaces** (i.e. SACs, SPAs, NHAs, pNHAs and local biodiversity areas); **blue spaces** (Coastal area, River Corrib, canals and other waterways, Lough Corrib and lakes, enclosed marine and wetlands); **green spaces** (citywide and city centre parks and neighbourhood parks); **community spaces** (greenways, recreational facilities and playgrounds, and protected views of special amenity value and interest); and **open spaces** (which includes institutional open space, recreation and amenity zoned lands and agricultural and high amenity lands).

This green network includes the River Corrib, lands at Menlo Castle, Galway Racecourse, NUIG Sports Campus, Cappagh Park, Ballinfoile Park, Ballindooley Lough as well as agricultural and high amenity zoned lands.

Plate 12.2 and **Plate 12.3** provide an overlay of the proposed road development onto the green network and green spaces/park network respectively. Further detail is also provided on **Figures 12.3.01** and **12.3.02**: Landscape Planning Aspects.

Section 4.4 of Galway City Development Plan discusses **Green Spaces** and Figure 4.4 of the Plan (refer to **Plate 2.3**) identifies the extent of parks within the city area.

To the northwest and north, most of the lands outside of the developed city are identified as part of the green network. The majority of the proposed road development is located within these areas.

These are also shown on **Figures 12.3.01** and **12.3.02**: Landscape Planning Aspects, which indicates that the proposed road development crosses lands zoned for 'recreational and amenity use' along the Bearna Stream (Ch. 5+230 - between Cappagh and Ballymoneen Roads) and at NUIG Sports Campus (Ch. 8+900) on the west side of the River Corrib. The proposed road development also crosses a large area of land zoned for agriculture and high amenity on the east side of the River Corrib.

Section 4.4.1 **Urban Woodland Parks and Trees** and Policy 4.4.1 seeks to manage, develop and integrate existing trees and hedgerows, including on development sites.

Section 4.5.1 **Greenways and Public Rights of Way** promotes the development of such linkages, including through the NUIG campus on the west bank of the River Corrib. The proposed road development would cross this greenway and other such links proposed to the northwest of the city (refer to **Figures 12.3.01** and **12.3.02**).

Plate 12.2: Green Network (within City Area) overlain with the proposed road development *(source: Figure 4.1 from City Development Plan with proposed road development overlain in black)*

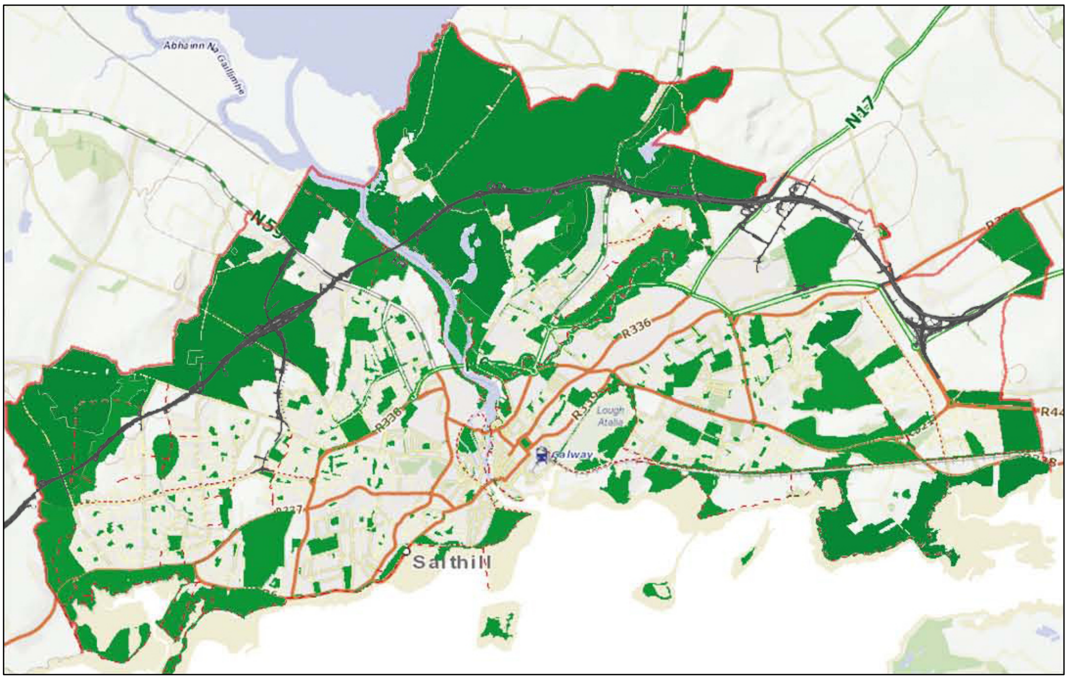
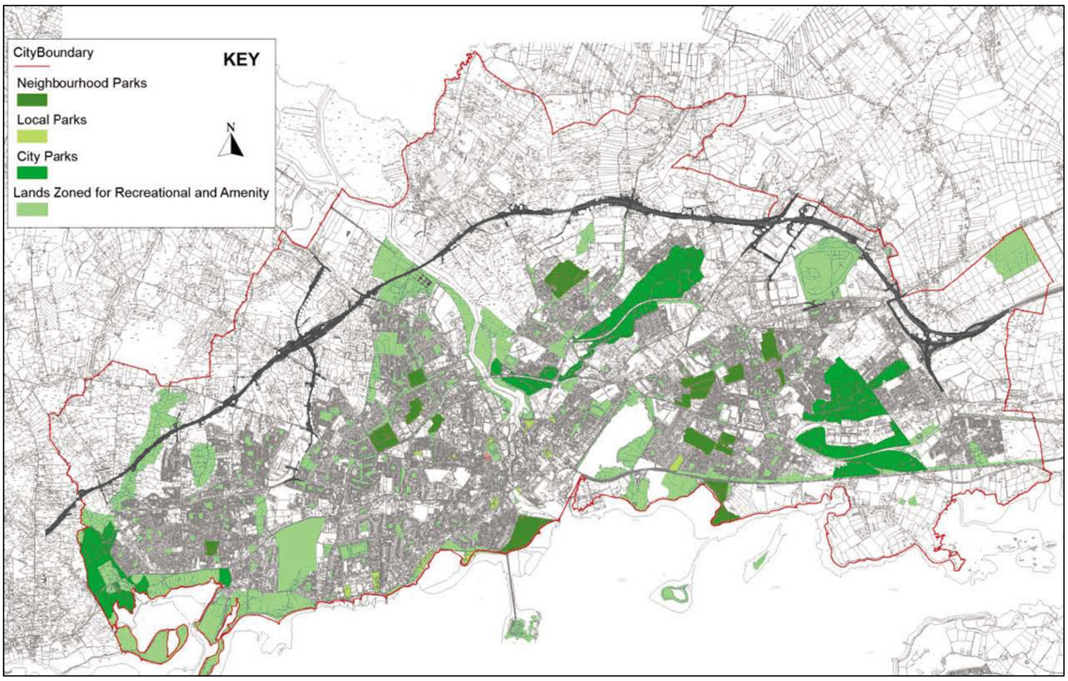


Plate 12.3: Park Network (within City Area) overlain with the Proposed Road Development *(source: Figure 4.4 from City Development Plan with proposed road development overlain in black)*



Section 4.5.3: **Views of Special Amenity Value and Interest**, identifies panoramic (V.1 to V.9) and linear protected views (V.10 to V.19). The location of the views are shown on **Figures 12.3.01** and **12.3.02** and views relevant to the proposed road development are listed in **Table 12.3**.

Table 12.3: Selected Panoramic Protected Views and Linear Protected Views

Panoramic Protected Views	
V.1	Panoramic views of the city and the River Corrib from Circular Road
V.2	Views from Dyke Road and Coolagh Road encompassing the River Corrib and Coolagh fen
V.6	Panoramic views of the city, and the Terryland Valley from parts of the Castlegar-Ballindooley Road
V.7	Views encompassing Lough Corrib from parts of the Quarry Road and Monument Road
Linear Protected Views	
V.10	Views from Galway-Moycullen Road (N59) of the River Corrib
V.14	Views northwards encompassing the River Corrib and adjoining lands from Quincentenary Bridge
V.19	Views encompassing Ballindooley Lough from parts of the Headford Road

Section 4.6.2: **Agricultural Lands** discusses general agricultural lands (zoned A) and high amenity agricultural lands (zoned G). The latter areas are illustrated on **Figures 12.3.01** and **12.3.02** and indicate that the proposed road development crosses this high amenity designation on the east side of the River Corrib. Policy

4.6.2 aims to prevent development that would give rise to environmental pollution or injury to general amenities, and also restricts the location of structures (other than structures with essential links to the waterway and public utilities) within ten metres of the River Corrib, in G zoned lands.

Section 4.7 of the plan sets out further **Specific Objectives** in relation to Natural heritage, Recreation and Amenity. These include:

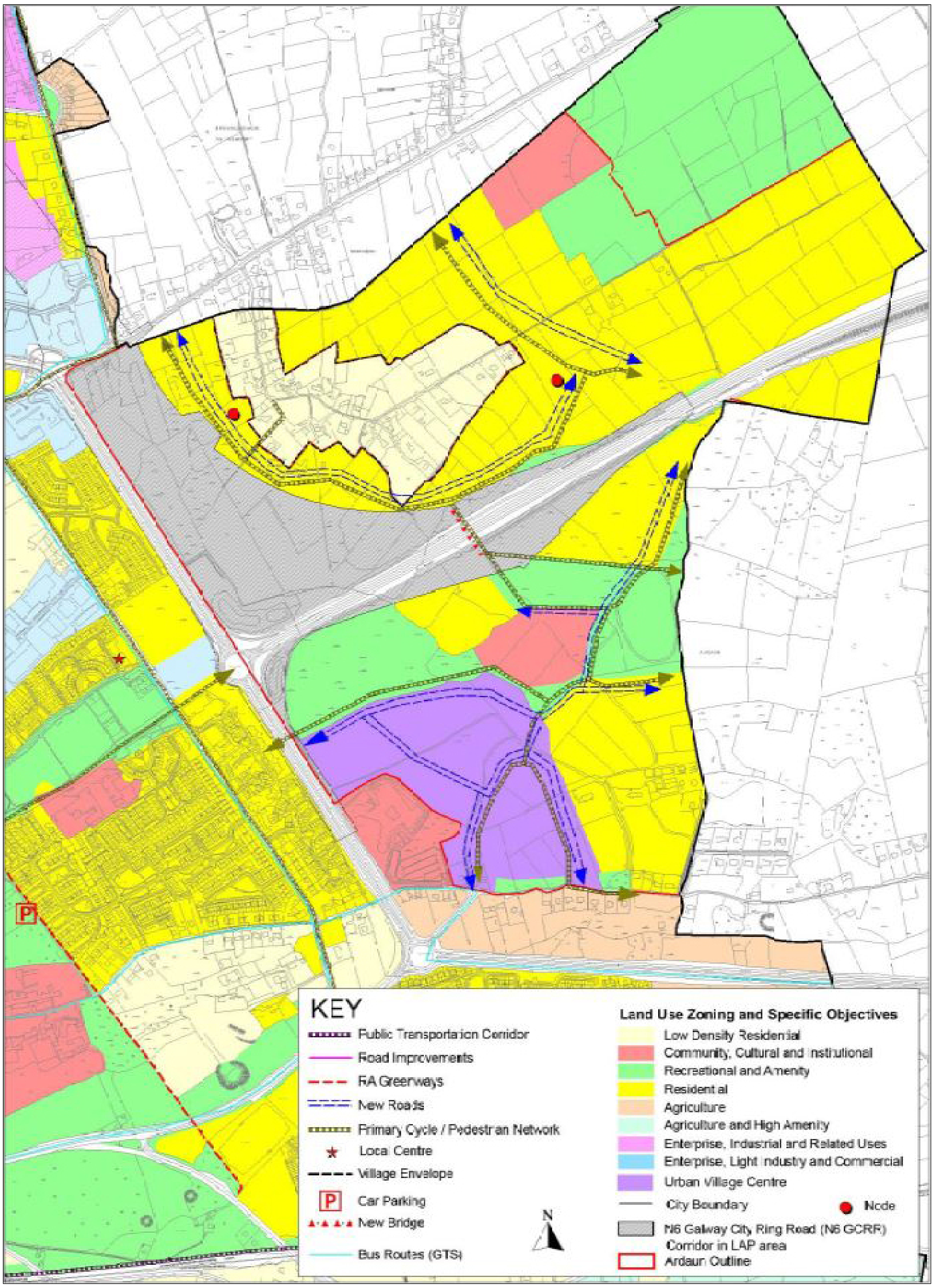
- A medium/long term objective to explore the potential for developing lands adjacent to Menlo Castle incorporating Menlough Woods as a park.
- A medium/long term objective to develop a walk along the eastern side of the River Corrib from the Dyke Road to the pier at Menlough.

Section 9.11 of Galway City Development Plan addresses **Light Pollution** and Policy 9.11 seeks to Ensure the design of external lighting minimises the incidence of light pollution, glare and spillage into the surrounding environment and has due regard to the visual and residential amenities of surrounding areas.

12.3.1.5 Ardaun Local Area Plan 2018-2024

The western section of the existing M6/N6 Galway to Dublin Motorway and the eastern end of the proposed road development falls within the area covered by the Arduan Local Area Plan (LAP). The LAP acknowledges that the '*N6 Galway City Ring Road route corridor reservation traverses the north-western section of the area*' (refer to Section 4 Ardaun Local Area Plan, page 8) and does not include development proposals within the corridor of the proposed road development. The Draft LAP proposes major development in the area, including new residential and commercial developments on c.81 hectares of an overall LAP area of c.164 hectares. The Draft LAP envisages significant changes to the landscape and visual setting of the area, which will be delivered on a phased basis over a long period of time.

Plate 12.4: Ardaun LAP – Land Use Zoning *(source: Figure 23 from Ardaun Local Area Plan 2018-2024)*



12.3.1.6 Galway County Development Plan 2015-2021

The Galway Transport Strategy (GTS) and the proposed road development are incorporated within Galway County Development Plan, as varied, and discussed in detail in Sections 5.3.4 and 5.3.4.6 of the Plan respectively. The GTS and the proposed road development are supported by Land Use Integration and Sustainable Transportation Policies TI-2 and TI-8 and Objectives TI-1 and TI-15.

In terms of landscape and visual considerations, Chapter 9 of Galway County Development Plan sets out policies and objectives in relation to **Heritage, Landscape and Environmental Management**. The strategic aims of the Plan (page 148) are to:

- To promote appropriate enhancement of the built and natural environment as an integral part of any development
- To promote a reasonable balance between conservation measures and development needs in the interests of promoting orderly and sustainable development
- To protect the landscape categories within the county and avoid negative impacts upon the natural environment
- To promote appropriate enhancement of the natural environment as an integral part of any development

Section 9.3 of Galway County Development Plan sets out General Heritage Policies, while Sections 9.4, 9.5, 9.6 and 9.7 relate to **Built Heritage, Architectural Heritage, and Archaeological Heritage**.

Objective AH 9 – 'Local Landscape and Place Assessment' supports local communities and residents in analysing character of local places and promotes its regeneration for the use and enjoyment of locals and visitors.

Objective AH 10 – 'Designed Landscapes' addresses surviving designed landscapes and promotes the conservation of their essential character, both built and natural.

Section 9.9 of Galway County Development Plan sets out a range of **Natural Heritage and Biodiversity** Policies and Objectives, which seek to protect, conserve and enhance the natural heritage and biodiversity of designated and non-designated sites, ecological networks and linear features such as hedgerows, stonewalls, water resources, geological and geomorphological systems, bats and bat habitats, eskers, the coastal zone, inland waterways, riparian zones and soil and groundwater; to promote green infrastructure; to implement national and county heritage plans and biodiversity plans; to support measures for prevention, recording and eradication of invasive species; to promote the use of native species; and to take account of Management Plans prepared for European sites by the National Parks and Wildlife Service (NPWS).

Objective NHB 11 – 'Trees, Parkland/Woodland, Stonewalls and Hedgerows' seeks to: protect important trees and hedgerows; to promote the use of native species; and to retain natural boundaries, including stone walls and hedgerows, wherever possible or to replace with a similar boundary where removal is unavoidable.

Sections 9.10 and 9.11 of Galway County Development Plan sets out Policies and Objectives in relation to **Landscape Conservation and Management** and to the consideration of landscape character, and where appropriate, to the preservation and enhancement of character, views and prospects, amenities of places and features of natural beauty or interest.

Section 9.10 of Galway County Development Plan notes that County Galway has been sub-divided into 25 **Landscape Character Areas** (LCAs), each of which has been attributed landscape values and sensitivity ratings. As landscape character relates to both county and city administrative areas this is discussed in further detail in **Section 12.3.1.2** of this chapter.

Section 9.12 and 9.13 of Galway County Development Plan refers to **Focal Points and Views** and to Objective FPC 1 – Development Management, which seeks to preserve focal points and views as listed in Map FPV1 of Galway County Development Plan. It is noted that this objective shall be balanced against the need to develop key infrastructure to meet the strategic aims of the Plan, and have regard to the zoning objectives of serviced development land within Galway Metropolitan Area.

Focal Points/Views Map FPV1 (of Galway County Development Plan) indicates that there are 5 focal points/views on or close to the proposed road development (Refer to **Figures 12.3.01** and **12.3.02**). These are:

71 – View of Headland Illaunafamona (700m+ from proposed road development).

72 – View of the sea from north of Bearna (750m section of proposed road development (Ch. 2+600 to Ch. 3+350) passes through northern extent of area from which view is identified).

73 – View of Lough Inch from the surrounding Third Class Roads (proposed road development passes immediately south of area from which view is identified)

74 – View of North Clare Coast (westernmost 2.85km section of proposed road development (Ch. 0+000 to Ch. 2+850) crosses into eastern portion of area from which view is identified).

75 – View of Loch Bhain Ui Choinc

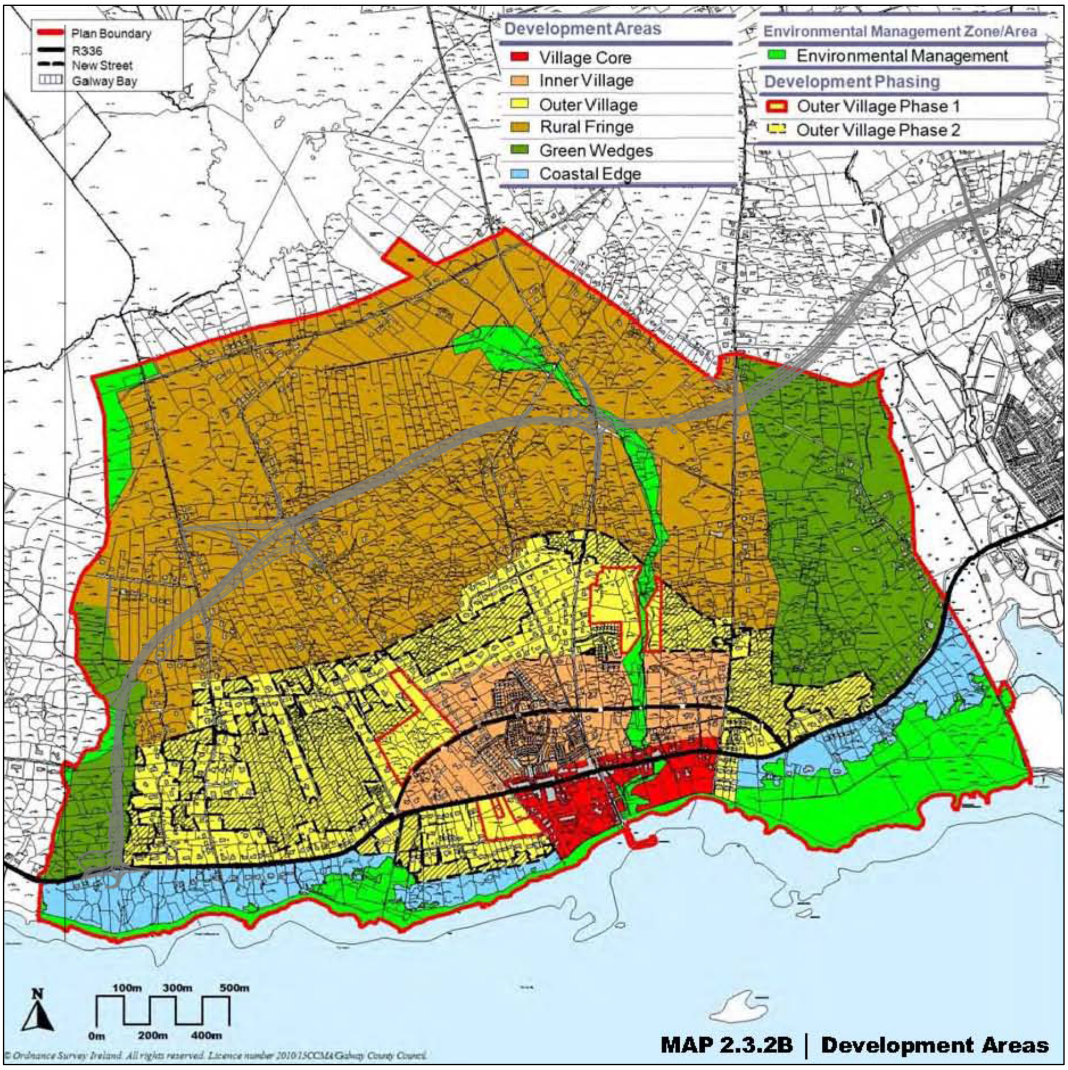
76 – View of Lough Corrib (1.45km section of proposed road development (Ch. 8+200 to Ch. 9+650) passes through southern end of area from which view is identified).

12.3.1.7 Bearna Local Area Plan 2007-2017

Section 2 of the Bearna Local Area Plan sets out the policies and objectives in relation to **Development Strategy**. Sub-section 2.3.2 discusses Land Use Strategy and identifies landscape designations. The designations are overlain with the proposed road development on **Plate 12.5**. The designations/land use objectives include:

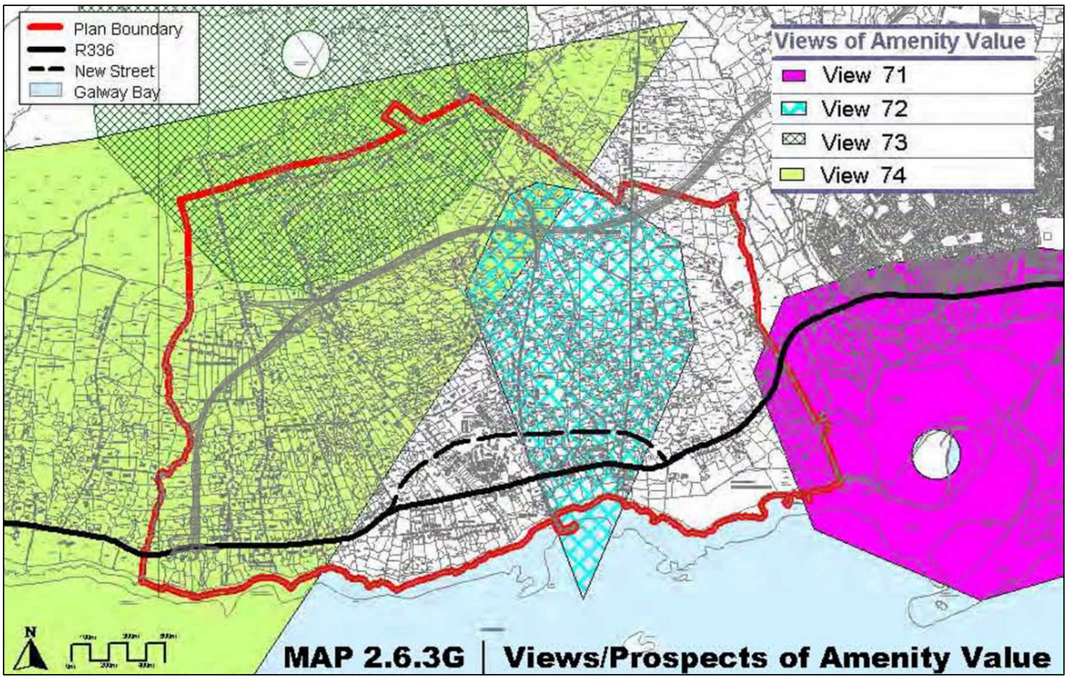
- Objective LU6: ‘Rural Fringe Area’, which seeks to protect the rural landscape north of Bearna from inappropriate and ribbon development. This area is also described in more detail in Sub-section 3.4 of the Bearna Local Area Plan. The proposed road development passes through centre of the rural fringe area.
- Objective LU7: ‘Green Wedges Area’, which seeks to retain areas adjacent to Sruthán Na Libeirtí (west) and Barna Woods (east) as green landscape wedges separating Bearna from Na Forbacha in the west and from Galway City to the east. These areas are also described in more detail in Sub-section 3.5 of the LAP. The proposed road development passes north south through western green wedge along Sruthán Na Libeirtí.
- Objective LU8: ‘Coastal Edge Area’ seeks to protect the coastal edge and high amenity area and retain potential for recreation, amenity, conservation and visual amenity. This area is also described in more detail in Sub-section 3.6 of the Bearna Local Area Plan. The proposed road development ties in to existing R336 at northern boundary of coastal edge area.
- Objective LU9: ‘Environmental Management Zone/Area’ seeks to protect areas with high biodiversity, landscape, amenity, and/or flood risk potential. These areas are also described in more detail in Sub-section 3.7 of the Bearna Local Area Plan. A c.150m section of the proposed road development passes through an environmental management zone/area along the Sruthán Na Libeirtí (Ch. 0+500). A further short section (c.100m) of the proposed road development at the proposed Bearna East Roundabout also crosses a narrow section of a second environmental management zone/area located along the Trusky Stream (Ch. 2+800).

Plate 12.5: Development Area Map from Bearna LAP overlain with proposed road development (in Grey)



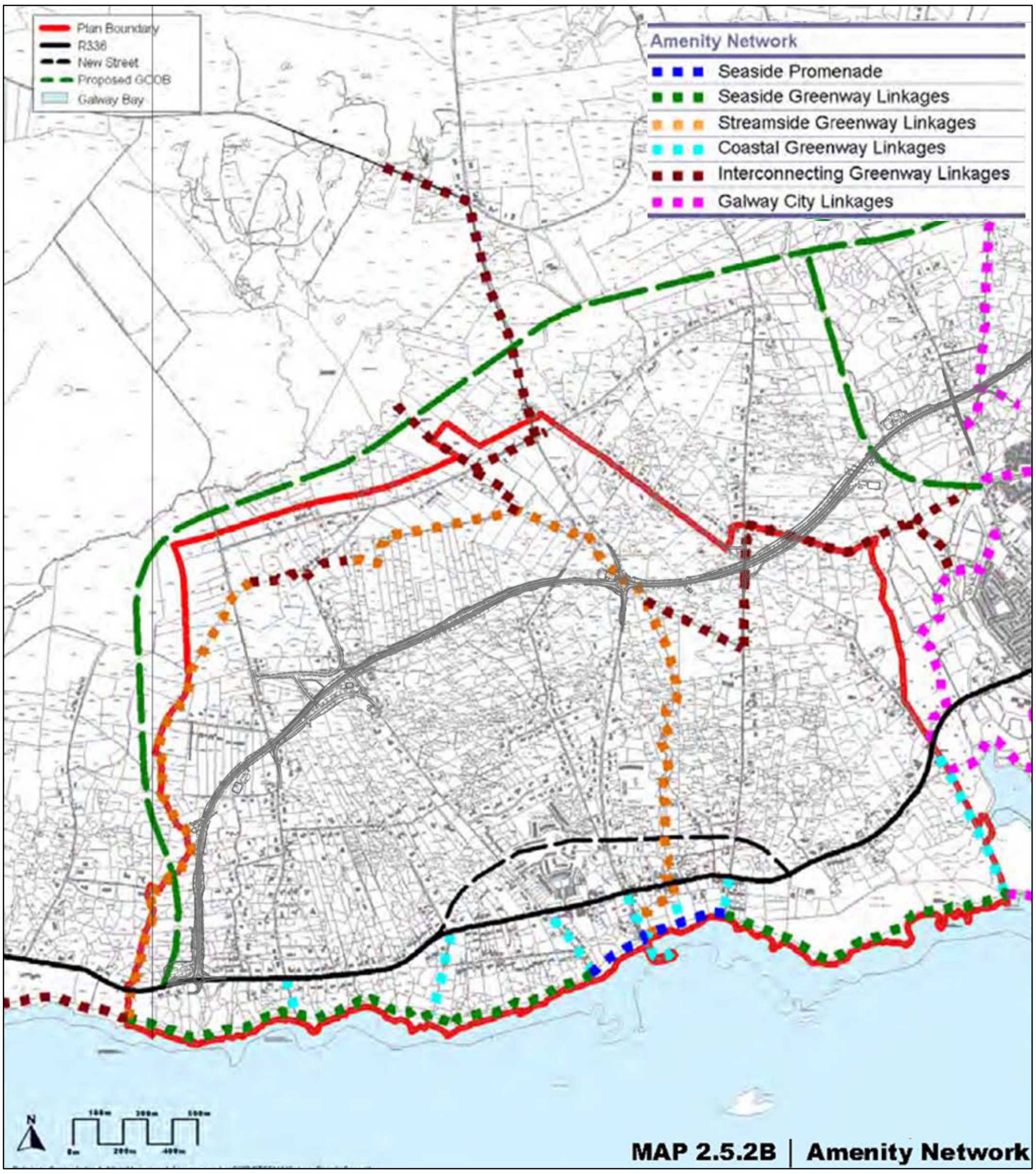
Policy 2.4.2B and Objectives VD12 to VD17 of the local area plan, which relate to **Landscape, Open Space, Views and Prospects**, seek to enhance green networks, integrate new development with the landscape, and landscape features, including streams, trees and hedgerows, and promote ecological landscaping. Objective VD14 Views and Prospects reflects the policy of Galway County Development Plan in relation to the protection of Views 71, 72, 73 and 74 as discussed under **Section 12.3.1.3** above (refer to **Plate 12.6** and **Figures 12.3.01** and **12.3.02** also).

Plate 12.6: Prospects Map from Bearna LAP overlain with proposed road development (in Grey)



Policy 2.5.2B and Objectives CF13 to CF19 of the local area plan relate to the **Amenity Network**. In particular Objectives CF15 and CF17 seek to promote streamside greenway linkages, loops and interconnections along Trusky Stream and Sruthán Na Libeirtí and on to a potential future coastal amenity park/promenade. These objectives are further supported by Objective CF18 which promotes the use of existing boreens and field or property boundaries or other routes as appropriate/agreed to improve the amenity network. The proposed road development crosses streamside greenways and interconnecting greenway linkages – refer to **Plate 12.7**.

Plate 12.7: Amenity Network Map from Bearna LAP overlain with proposed road development (in Grey) *(Note: Route of previous N6 Galway Outer Bypass (2006) is shown in dashed green line)*



Policy 2.6.3D and Objectives NH10 to NH13 of the local area plan, which relate to the **Nature Conservation and Biodiversity**, address designated and non-designated sites, tree protection, interconnectivity and the retention, replacement of natural boundaries, including stone walls.

Likewise, Policy 2.6.3F and Objectives NH19 to NH22 of the local area plan, which relate to the **Field Patterns, Hedgerows and Stone Walls**, also address retention, where possible of field patterns and boundaries, including hedgerows and stone walls.

Policy 2.6.3I and Objectives Nh32 to NH35 of the local area plan relate to **Landscape Character and Views**; to the landscape value and sensitivity of such character; to designated views and prospects, and to the scenic qualities of the coastal zone (particularly 50m either side of the coastal road). Objective NH32 also notes potential for consideration of designation of this coastal zone as an Area of Special Amenity or as a Landscape Conservation area. The tie-in of the proposed road development with the existing R336 falls within the stated corridor of 50m to either side of the coast road. This area has not been designated as an Area of Special Amenity or as a Landscape Conservation area.

Policy 2.6.3J and Objectives NH36 to NH44 of the local area plan relate to the **Coastal Zone**, and to its sensitivities, protection and conservation, as well as to its potential for amenity/linkages/walkways.

12.3.1.8 Gaeltacht Local Area Plan 2008-2018

In an overall sense, the Gaeltacht LAP reiterates the landscape and visual considerations and objectives as set out in the Galway County Development Plan 2015-2021. In particular, Environmental Policies PL1, PL2 and PL3 refer to landscape and Policy OHE5 addresses biodiversity and ecological networks. Part of the proposed road development falls within District F Imeall Na Cathrach/An Eachréid, which abuts and surrounds Galway City. The Plan notes that "*It is the area under greatest pressure from City growth and must cope not only with the changes to its language and culture but with the constant demand for infrastructure and services which this now peri-urban area*."

12.3.1.9 Historic Gardens and Designed Landscapes

The National Inventory of Architectural Heritage (NIAH) records properties under Historic Gardens and Designed Landscapes. The properties listed are given a historic feature richness index rating (FRI) ranging between 0 to 16 depending on the quality of the extant features and the state of their preservation. Where no, or virtually no recognisable features remain, properties are considered as having '0' FRI. Properties with a low rating (*i.e.* FRI of less than 5) will have experienced significant loss and/or alteration of the original layout of the historic garden and/or designed landscape. Nevertheless, even where a lower rating has been recorded, individual features may continue to have local landscape significance, *e.g.* peripheral mature woodland, avenues, parkland trees *etc*. Where the FRI rating is 5, or above, landscape elements retained on the ground continue to show significant features of the original landscape design intent and structure.

The properties listed in **Table 12.4** lie on or close to the proposed road development. However, not all of these historic properties are directly impacted or even indirectly impacted, *e.g.* in terms of impact on their setting. Historic demesnes with houses that have potential for visual impact have also been assessed, together with all other properties, within the visual impact schedule in **Appendix A.12.1** and within **Section 12.5.3.6** and **Section 12.5.4.6** of this chapter. A more detailed consideration of all aspects of architectural and cultural heritage is provided under **Chapter 13, Archaeological, Architectural and Cultural Heritage**.

Table 12.4: Historic Gardens and Designed Landscapes located along the Proposed Road Development (PRD)

Figure Ref.	Name and location relative to PRD:	FRI Index	NIAH Comments & Principal Retained Features
P008-043 (**Figure 12.1.12**)	Bushypark House demesne. Mainline of PRD over 600m+ from house. Proposed N59 Link Road North ties into existing N59 Moycullen Road along southern demesne boundary.	2	NIAH Comments: Main features substantially present - peripheral features unrecognisable. Much of the structural footprint of the designed landscape shown on the 1836 - 1846 OS map is visible in aerial photography but features are in a degraded condition. Note: The principal structure, 'Bushypark House', is still extant and is listed as a protected structure. Some limited residential development has taken place within the demesne lands.
N/A	Ashley Park demesne. 300m+ from PRD.	1	NIAH Comments: Virtually no recognisable features. Housing has been constructed on this site. Virtually no features of the designed landscape shown on the 1836 - 1846 OS map are visible in aerial photography.
P009-001 (Dangan House – 2nd Ed. Mapping) (**Figure 12.1.07**)	Dangan Cottage, Dangan House, Dangan Nunnery, Mary Ville demesnes. (Effectively forming one combined or conjoined landscape). PRD passes through northern portion of original conjoined demesne lands.	1	NIAH Comments: Virtually no recognisable features remain. Industrial and sporting facilities have been constructed on this site. Note: NIAH garden survey only includes an entry for Dangan House, which, like Nunnery, on the first edition map was located on the edge of the River Corrib. Neither property survives today or are indicated on second edition mapping. Dangan Cottage appears in the same place on both first and second edition mapping. However, the property is no longer present and a sports pitch has been constructed on the location

Figure Ref.	Name and location relative to PRD:	FRI Index	NIAH Comments & Principal Retained Features
			Mary Ville is not shown on first edition mapping, but does appear on second edition mapping, together with a new reference for Dangan House in a different location to that shown on the first edition mapping.
P009-003 (**Figure 12.1.07**)	Menlo Castle demesne. PRD passes through southeast portion of original demesne – c.150m from castle ruins.	6	NIAH Comments: Main features unrecognisable – peripheral features visible. A river runs alongside this site. Much of the parkland shown on the 1836 - 1846 OS map has been divided into smaller fields. Note: Today the principal castle structure survives as a dramatic ruin on the edge of the river (P009-003). The principal structure and its entrance are both protected structures.
PG14-016 (site of) (**Figure 12.1.14**)	Ballybrit House demesne. 1km+ from PRD. City East Business Park Junction works are within demesne.	0	NIAH Comments: Virtually no recognisable features. Note: Today the demesne is completely covered by industrial and residential development and the site of the house lies beneath Bóthar na dTreabh (N6).

12.3.1.10 Landscape and Visual Significance and Sensitivity

The main features of significance and sensitivity in the receiving landscape (in general west to east order) are:

- The semi-natural landscape character of marginal grasslands, scrub plantings, small stream valleys and stone walls to the west and north of Bearna Village
- Environmental Management and Open Space Areas, protected views and prospects, and proposed greenways and linkages west and north of Bearna Village
- The open rising landscape, including open space lands, northwest of Galway City
- The River Corrib corridor and its wider landscape setting, which includes the prominent ruins of Menlo Castle, as well as a diverse mosaic of semi-natural and man-influenced landscapes, riparian plantings, grasslands, scrub and woodland. Protected views and prospects and lands on east bank designated as High Amenity Agriculture

- The recreation, sports and amenity lands of NUIG Sports Campus and surrounding areas. Lands on west bank of River Corrib designated as Recreation, Open Space
- The limestone, grassland and scrub landscape with stone walls northeast of Galway City
- The wider drumlin and valley landscape setting with protected views and prospects around Ballindooley Lough
- The open recreational lands of Galway Racecourse and surrounding areas

The main features of visual significance and sensitivity in the receiving landscape (in a general west to east order) are:

- The presence, prominence and visual amenity of residential property and development in general, especially at the:
    - west and north of Bearna, at Foraí Maola Road, at Troscaigh Road and at Ann Gibbons and Bearna to N59 Moycullen Road
    - west/northwest of the city, at Aille Road, Cappagh Road, and Ballymoneen
    - northwest of the city, at Rahoon Road and Clybaun Road, Letteragh Road and at Chloch Scoilte.
    - to either side of the N59 Moycullen Road north of the city, at Knocknafroska, Barnacranny, Upper Dangan and Aughnacurra and also at Ballagh and Bushypark
    - north/northeast of the city, at Bóthar Nua, Seanbóthar
    - northeast of the city, at N84 Headford Road and at Hynes' Bóithrín, Spellman's Bóithrín and School Road and setting of Castlegar Village
    - east of the city, at N83 Tuam Road, Racecourse Avenue, Ballybrit Crescent, and the village of Coolagh-Briarhill
- The location of a number of protected views and prospects.
- The visual amenity associated with NUIG Sports Campus.
- The visual amenity associated with the River Corrib corridor, including the setting of Menlo Castle.
- The visual amenity associated with Galway Racecourse.

12.4 Characteristics of the Proposed Development

A detailed description of the proposed road development and construction activities are provided in **Chapter 5, Description of Proposed Road Development** and **Chapter 7, Construction Activities**.

The main characteristics of the proposed road development of relevance to the landscape and visual assessment are outlined under construction and operation phases in the following.

12.4.1 Construction Phase

The main characteristics of the construction stage of the proposed road development that have potential for landscape and visual impact are:

- Site mobilisation and establishment, tree and vegetation removal, fencing of lands, provision of site compounds
- Removal of properties, boundaries, amenities
- Normal landscape disturbance and activity, including removal of topsoil, general earthworks and operation of construction traffic
- Construction of significant earthworks, including cuttings and rock cuttings (< 3m deep) and embankments (< 3m high)
- Construction of the new road, link roads and associated local road re-alignments, including provision of noise barriers, lighting, gantries signage, *etc*.
- Construction of new structures, including under and overbridges, culverts, a c.650m long bridge crossing of the River Corrib and its valley, a c.310m length of viaduct, and 2 separate sections of tunnel – one of c.270m length at Lackagh Quarry, and a second of c.240m length at Galway Racecourse.
- Demolition and modification of part of NUIG Sports Pavilion, provision of new sport pitches at NUIG Sports campus and provision of re-organised stabling and parking facilities at Galway Racecourse.
- Other related works, including diversion of existing services, provision of new services, provision of attenuation and wetland ponds, drainage facilities, new road boundaries and landscape works, *etc*.

12.4.2 Operational Phase

The main characteristics of the operation stage of the proposed road development that have potential for landscape and visual impact are:

- The presence and operation (traffic) of the road and its proximity to residential, amenity and other property
- The prominence of embankments and cuttings in the landscape
- The prominence of elevated structures such as bridges and the viaduct
- The presence of noise barriers, gantries signage, *etc*.

- The presence of additional roadside lighting
- The movement of traffic on the proposed road development, including on bridges, embankments, tunnel portals *etc*.

12.5 Evaluation of Impacts

12.5.1 Introduction

The proposed road development crosses a diverse rural/sub-urban edge landscape to the west, north and east of typical city development. Residential properties are a common feature along most sections of the proposed road development, particularly at the crossing of local roads west and northwest of Galway, at the crossing of the N59 Moycullen Road, at the N84 at Ballindooley, at Castlegar, and at Ballybrit, Dougishka and Coolagh-Briarhill.

Within this landscape, the construction associated with the proposed road development will give rise to significant and profound negative impacts in terms of disturbance to the existing landscape and visual character of the area and to properties located close to the proposed road development.

While landscape and visual impacts will tend to be most pronounced during the construction and early operation stages, the proposed road development will, as with all road schemes, also have some degree of residual permanent effect on its landscape and visual environment.

12.5.2 Do Nothing Impact

Landscapes and properties along the proposed road development would not experience the negative landscape and visual impacts that are associated with the proposed road development and their existing setting would experience little or no change in the short to medium-term other than from likely further residential and city-related development.

12.5.3 Potential Construction Impacts

Details of the anticipated three-year construction period of the proposed road development is set out in **Chapter 7, Construction Activities**.

Potentially impacted features and landscape and visual impacts are described on a section by section basis below. An assessment of the overall construction stage visual Impact is also discussed separately in the **Section 12.5.3.6** of this chapter. Potentially impacted properties are indicated on **Figures 12.1.01** to **12.1.14** and recorded in **Appendix A.12.1**.

12.5.3.1 Ch. 0+000 to Ch. 6+300 (Landscape Character Area 9)

The following construction-related aspects give rise to potential for landscape and visual impacts within this section of the proposed road development:

- **Properties:** Ten residential properties are to be acquired with consequent impact on existing community and landscape/visual setting (refer to **Figures 12.1.01** to **12.1.05**). These are mainly located at the crossing of local roads where ribbon-style residential development is a feature along such roads.

  Locally significant short-term negative impact

- **Vegetation:** Removal of vegetation is very limited and is primarily focused on areas of scrub vegetation, short sections of gappy hedgerows and occasional small trees – often around properties to be acquired (refer **Figures 12.4.01** to **12.4.05**).

  No significant impact arises

- **Landscape Features:** There is substantial impact on, and removal of, stone field boundary walls. While often dilapidated and overgrown with scrub, these walls are a notable feature of this relatively open, rough-grained landscape.

  Locally significant short-term negative impact

- **Embankments:** Significant embankments (i.e. >3m high) are limited in extent and scale. While some short sections of lower embankments (i.e. < 3m high) are required to cross local low points, the main sections of embankment (total c.2.55km) with approximate maximum heights are:

  - Ch. 0+550 to Ch. 1+150 (up to c.6m high)
  - Ch. 1+200 to Ch. 1+600 including Troscaigh/Foraí Maola Overbridge Link (up to c.7m high)
  - Ch. 1+900 to Ch. 2+250 (up to c.7m high)
  - Ch. 2+800 to Ch. 3+050 (up to c.6m high)
  - Ch. 3+900 to Ch. 4+000 (up to c.7m high)
  - Ch. 4+100 to Ch. 4+350 (up to c.5m high)
  - Ch. 4+750 to Ch. 5+000 (up to c.6m high)
  - Ch. 5+950 to Ch. 6+300 (up to c.9m high)

  Locally significant short-term negative impacts

- **Cuttings:** Significant cuttings (i.e. > 3m deep) are limited in extent and scale. While some short sections of shallow cut (i.e. < 3m deep) are required to cross local ridges/high points, the main sections of cut (total c.0.95km) with approximate maximum depth are:

  - Ch. 3+150 to Ch. 3+900 (up to c.5m cut – rock expected at lower depths)
  - Ch. 5+350 to Ch. 5+530 (up to c.9m cut – rock expected at lower depths)

  Locally moderate short-term negative impacts

- **Visual Impacts:** Significant negative visual impacts arise for residential properties, especially in the crossing of local roads (at R336, Foraí Maola, Troscaigh, Ann Gibbons, Aille, Cappagh, Ballymoneen, Rahoon and Letteragh) and at the proposed Troscaigh/Foraí Maola Overbridge Link (Ch. 1+380). Refer to **Section 12.5.3.6** and **Figures 12.1.01** to **12.1.05**.

  Overall there will be a significant short-term negative visual impact

- **Landscape Planning:** Construction of part of the proposed road development is sited within a Green Wedge Ch. 0+000 to Ch. 0+750) and also passes through a short section of an Environmental Management Zone[4] (at Ch. 0+550) located along Sruthán Na Libeirtí. The construction of the proposed road development also crosses a further narrow section of an Environmental Management Zone at Trusky Stream (Ch. 2+850), as noted in the Bearna Local Area Plan.

Construction of part of the proposed road development crosses the northern edge of open space zoning (in Galway City Development Plan) east of Aille Road (Ch. 3+850); and again at Cappagh/Ballynahown/Keeraun (c.Ch. 4+700 to Ch. 5+300).

The proposed road development crosses the greenway link objectives at Trusky Stream (Ch. 2+850); at Aille Road (Ch. 3+300) and at Cappagh Road (Ch. 4+450), Boleybeg Bóithrín (Ch. 4+550) and at Keeraun Bóithrín (Ch. 5+950). Construction stage activities will result in temporary restrictions on the use of these local roads.

The construction of the proposed road development falls within the fore/middle-ground of View No. 74 - View of North Clare Coast and of View 72 – View of Sea from north of Bearna (as noted in Galway County Development Plan and Bearna LAP). Large-scale construction of the proposed road development will be visually distracting and incongruous in the foreground of the otherwise long range views.

<u>Overall there will be a significant short-term negative landscape planning impact</u>

- **Landscape Character:** Notwithstanding the extent of existing residential development, the construction of the proposed road development will give rise to substantial disruption of local landscape character – especially in the provision of the Troscaigh/Foraí Maola Overbridge Link. The construction will have limited impact on the more locally sensitive Bearna Coastal Fringe – especially south of the R336 Coast Road.

  The construction of proposed road development will have only slight to moderate negative impact on the overall Landscape Character Area (LCA 9).

  <u>Overall there will be a moderate to significant short-term negative impact on local landscape character</u>

12.5.3.2 Ch. 6+300 to Ch. 8+000 (Landscape Character Area 12)

The following construction-related aspects give rise to potential for landscape and visual impacts within this section of the proposed road development:

- **Properties:** Three residential properties are to be acquired with consequent impact on the existing community and landscape/visual setting (refer to **Figures 12.1.05** to **12.1.06** and **Figures 12.1.12** to **12.1.13**). These are located at Letteragh (1) and at the N59 Letteragh Junction (2).

  <u>Locally moderate short-term negative impact</u>

[4] for Environmental Management Zone: Refer to Objective LU9 of Bearna Local Area Plan and to Section 12.3.1.6 of this Chapter of the EIAR

- **Vegetation:** Removal of vegetation is limited and is primarily focused on areas of scrub vegetation, short sections of gappy hedgerows and occasional trees – generally around the proposed N59 Letteragh Junction (refer **Figures 12.4.05** to **12.4.06** and **Figures 12.4.12** to **12.4.13**).

  Locally slight short-term negative impact

- **Landscape Features:** There is considerable impact on, and removal of, stone field boundary walls. While often dilapidated and overgrown with scrub, these walls are a notable feature of this relatively open landscape.

  Locally moderate to significant short-term negative impact

- **Embankments:** Some significant embankments (i.e. > 3m high) arise. While some short sections of lower embankments (i.e. < 3m high) are also required to cross local low points, the main sections of embankment (total c.1.15km) with approximate maximum heights are:
  - Ch. 6+300 to Ch. 6+550 (up to c.12m high)
  - Ch. 6+800 to Ch. 6+950 (up to c.10m high)
  - Ch. 7+000 to Ch. 7+550 (various embankments associated with approach to and N59 Letteragh Junction - up to c.6m high)
  - Ch. 1+500 to Ch. 1+700 on N59 Link South (up to 7m high)

  Locally moderate short-term negative impacts

- **Cuttings:** Some significant cuttings (i.e. > 3m deep) arise. While some other short sections of shallow cut (i.e. < 3m deep) are required to cross local ridges/high points, the main sections of cut (total c.0.85km) with approximate maximum depth are:
  - Ch. 7+550 to Ch. 8+000 (various cuttings associated with N59 Letteragh Junction - up to c.11m cut. Rock expected at lower depths)
  - Ch. 0+050 to Ch. 0+450 on N59 Link North (up to 8m cut)

  Locally significant short-term negative impacts

- **Visual Impacts:** Significant negative visual impacts for residential properties, especially in the crossing of local roads at Letteragh and Rahoon and at the tie-in to the existing N59 Moycullen Road at Ballagh/Bushypark). Refer to **Section 12.5.3.6** and **Figures 12.1.05** to **12.1.06** and **Figures 12.1.12** to **12.1.13**.

  Overall there will be a significant short-term negative visual impact

- **Landscape Planning:** The construction of the proposed road development falls within the context of Linear View 10 of the River Corrib from the N59 Moycullen Road and County View 76 of Lough Corrib from the Ballagh / Bushypark area. Construction of the proposed N59 Link North will be visually distracting and incongruous in the foreground of longer range elevated views of Lough Corrib in View 76. No significant impact arises for View 10.

  Overall there will be a slight to moderate short-term negative landscape planning impact

- **Landscape Character:** Notwithstanding the rural/city edge nature of the landscape and the extent of residential development, the construction of the proposed road development will give rise to substantial disruption of the open elevated local landscape character.

The construction of proposed road development will have only slight to moderate negative impact on the overall Landscape Character Area (LCA 12).

Overall there will be a significant short-term negative impact on local landscape character

12.5.3.3 Ch. 8+000 to Ch. 11+800 (Landscape Character Area 11)

The following construction-related aspects give rise to potential for landscape and visual impacts within this section of the proposed road development:

- **Properties:** Thirteen residential properties are to be acquired with consequent significant impact on existing community and landscape/visual setting (refer to **Figures 12.1.06** to **12.1.08**). These properties are mainly located to either side of the N59 Moycullen road at Knockadoney/Bushypark (2), Ard na Locha (3) and Aughnacurra (6) on the east bank of the River Corrib, and at Bóthar Nua (2) on the west bank. A temporary acquisition of the NUIG Sports Pavilion is also proposed to allow for modification of the building to facilitate the proposed road development.

  Locally very significant/profound short-term negative impact at N59 Moycullen Road/Aughnacurra, and otherwise significant

- **Vegetation:** Substantial removal of vegetation within Aughnacurra residential estate and NUIG Sports Campus on the west bank; and southest of Menlo Castle; and in sections across limestone landscape of Menlough/Coolough on the east bank (refer **Figures 12.4.06** to **12.4.08**). Significant impact on woodland block south of Menlo Castle is particularly notable.

  Locally significant/very significant short-term negative impact

- **Landscape Features:** There is substantial impact on and removal of stone field boundary walls at Chloch Scoilte, Knocknabrona and Knocknafroska all west of the N59 Moycullen Road. There is a lesser impact on stone walls through the limestone areas of Menlough/Coolough on the east side of the river.

  Significant disruption and intrusion onto the recreational, amenity and sport grounds of NUIG Sports Campus; River Corrib watercourse and banks; distinctive setting of Menlo Castle; and the exposed limestone pavement areas in the east in Menlough/Coolough.

  Existing sports pitches impacted at NUIG Sports Campus are to be replaced with all-weather facilities.

  Locally very significant/profound short-term negative impact

- **Embankments and Structures:** Some very significant embankments (i.e. > 3m high) and structures are required through this section. The main sections of embankment (total c.1.575km) and elevated structures (including 650m long bridge) with approximate maximum heights of embankment are:

- Ch. 8+350 to Ch. 9+000 (up to c.8m high). Embankment includes bridge over existing N59 Moycullen Road and significant sections of high retaining walls through retained residential areas
- Ch. 8+850 to Ch. 9+500 Major elevated bridge structure across River Corrib and immediate landscape setting
- Ch. 9+500 to Ch. 10+100 Eastern tie-in to River Corrib Bridge (up to 18m high)
- Ch. 10+105 to Ch. 10+425 Viaduct over limestone pavement
- Ch. 10+425 to Ch. 10+550 (up to c.10m high)
- Ch. 11+500 to Ch. 11+800 (up to 9m high – but located on excavated floor of Lackagh Quarry)

<u>Locally profound short-term negative impact</u>

- **Cuttings and Structures:** Cuttings are very limited through this section, and lead mainly to the proposed tunnel into Lackagh Quarry.

  The main sections of cut (total c.0.4km) and other structures with approximate maximum depth of cuttings are:

  - Ch. 10+950 to Ch. 11+150 (cutting leading to Lackagh Quarry - up to c.8m cut. Rock expected at lower depths) Ch. 11+150 to Ch. 11+350 Tunnel into Lackagh Quarry

  <u>Locally slight / moderate short-term negative impacts</u>

- **Visual Impacts:** Profound negative visual impacts for residential properties, especially to either side of N59 Moycullen Road; through NIUG Sports Campus; at crossing of River Corrib, including at Menlo Castle; as well as at Bóthar Nua and Seanbóthar on east bank of River Corrib. Construction of the bridge, associated embankments and viaduct will have a significant visual impact and give rise to city-wide attention and interest in the process. Refer to **Section 12.5.3.6** and **Figures 12.1.06** to **12.1.08**.

  <u>Overall profound short-term negative visual impact</u>

- **Landscape Planning:** The construction of the proposed road development crosses recreation and amenity zoned lands on west bank of River Corrib; and High Amenity Agricultural lands on east bank.

  The proposed river crossing is within context of County View 76 of Lough Corrib from the Dangan area. Construction of proposed bridge and associated earthworks will be visually prominent, distracting and incongruous in View 76.

  <u>Overall profound short-term negative landscape planning impact</u>

- **Landscape Character:** Construction of the bridge and associated works especially on east bank will have a significant impact on the local landscape character of this broad river valley landscape, on its feature castle ruin and on the semi-natural setting of the east bank. The proposed viaduct rises on to the locally elevated east side of the river valley corridor and as such the construction of the structure will be visible from more elevated locations on the west bank of the river.

  <u>Overall very significant/profound negative impact on local landscape character</u>

12.5.3.4 Ch. 11+800 to Ch. 14+200 (Part of Landscape Character Area 11 as well as Landscape Character Area 5)

The following construction-related aspects give rise to potential for landscape and visual impacts within this section of the proposed road development:

- **Properties:** Twenty-five residential properties are to be acquired with consequent significant impact on existing community and landscape/visual setting (refer to **Figures 12.1.08** to **12.1.10**). These properties are mainly located along the N84 Headford Road at Ballindooley/Castlegar (14) Castlegar Village (8) and N83 Tuam Road (3).

  <u>Locally profound short-term negative impact at Castlegar and local significant impact at N84 Headford Road and elsewhere</u>

- **Vegetation:** Limited removal of vegetation around residential areas at N84 Headford Road and Castlegar and along other limited sections (refer **Figures 12.4.08** to **12.4.10**).

  <u>Locally slight to moderate short-term negative impact</u>

- **Landscape Features:** There is moderate impact on and removal of stone field boundary walls through Castlegar.

  <u>Locally moderate short-term negative impact</u>

- **Embankments and Structures:** Series of embankments. The main sections of significant embankment (i.e. > 3m high) and elevated structures with approximate maximum heights of embankment (c.1.0km overall) are:
  - Ch. 11+950 to Ch. 12+500 (up to c.14m high). Embankment includes bridge over existing N84 Headford Road
  - Ch. 13+650 to Ch. 14+150. Embankment (up to 12m high) includes bridge over existing N83 Tuam Road

  <u>Locally very significant short-term negative impact</u>

- **Cuttings and Structures:** Various significant cuttings (i.e. > 3m deep) through this section – including deep cutting southwards out of Lackagh Quarry (Ch. 11+800 to Ch. 11+950).

  The main sections of cut (total c.1.0km) with approximate maximum depth are:
  - Ch. 11+800 to Ch. 11+950 (cutting out of Lackagh Quarry - up to c.18m cut. Rock expected through most of depth)
  - Ch. 12+550 to Ch. 12+850 through ridge at Castlegar (up to 7m deep – rock at lower levels)
  - Ch. 13+050 to Ch. 13+600 through ridge at Castlegar (up to 12m deep – rock at lower levels)

  <u>Locally very significant short-term negative impacts</u>

- **Visual Impacts:** Very significant/profound negative visual impacts for residential properties, especially to east of crossing of N84 Headford Road and through Castlegar generally. Refer to **Section 12.5.3.6** and **Figures 12.1.08** to **12.1.10**.

  <u>Overall profound short-term negative visual impact</u>

- **Landscape Planning:** The protected historic settlement of Castlegar Village lies to the south of the proposed road development.

  The landscape surrounding Ballindooley Lough immediately north of the proposed road development is designated as High Amenity Agriculture.

  The construction of the proposed road development falls within the context of protected views V6 and V19.

  <u>Overall moderate - significant short-term negative landscape planning impact</u>

- **Landscape Character:** Construction of proposed embankments, cuttings as well as a c.650m long bridge structure and a c.320m long viaduct structure will have a substantial impact on the rolling hill and valley nature of the local landscape character.

  <u>Overall significant/very significant negative impact on local landscape character</u>

12.5.3.5 Ch. 14+300 to Ch. 17+540 (Landscape Character Area 3)

The following construction-related aspects give rise to potential for landscape and visual impacts within this section of the proposed road development:

- **Properties:** Three residential properties are to be acquired with consequent minor impact on existing community and landscape/visual setting (refer to **Figures 12.1.10**, **12.1.11** and **12.1.14**). These properties are located along Racecourse Avenue and the R339 Monivea Road.

  <u>Locally slight short-term negative impact</u>

- **Vegetation:** Limited removal of scrub vegetation west of Coolagh-Briarhill (refer **Figures 12.4.10**, **12.4.11** and **12.4.14**).

  <u>Locally slight short-term negative impact</u>

- **Landscape Features:** There is substantial impact on and removal of stone field boundary walls at Ballybrit and Coolagh-Briarhill. The proposed road development crosses the line of an old mass path at Parkmore (Ch. 1+010 on Parkmore Link Road).

  <u>Locally moderate to significant short-term negative impact</u>

- **Embankments and Structures:** Series of embankments. The main sections of embankment (c.1.0km overall) and elevated structures with approximate maximum heights of significant embankment (i.e. > 3.0m high) are:
  - Ch. 14+200 to Ch. 14+400 (up to c.6m high). Embankments up to 15m high associated with loop link roads
  - Ch. 15+550 to End. Series of embankments up to 12m high with bridges and sections of retaining wall leading to and comprising proposed Coolagh Junction

  <u>Locally significant short-term negative impact</u>

- **Cuttings and Structures:** Various significant cuttings (i.e. >3.0m deep) through this section – including deep cutting into Lackagh Quarry (Ch. 11+800 to Ch. 11+950).

  The main sections of cut (total c.1.0km) with approximate maximum depth are:

  - Ch. 14+150 to Ch. 14+950 (up to c.10m deep). Cutting leading to Galway Racecourse Tunnel
  - Ch. 14+950 to Ch. 15+200 Cut and cover tunnel structure at Galway Racecourse
  - Ch. 15+200 to Ch. 15+400 (up to c.8m deep). Cutting leading from Galway Racecourse Tunnel

  <u>Locally significant short-term negative impacts</u>

- **Visual Impacts:** Very significant/profound negative visual impacts for residential properties, at Racecourse Avenue/Ballybrit Crescent and significant at Coolagh-Briarhill. Slight to moderate negative visual impacts at Dougishka. Refer to **Section 12.5.3.6** and **Figures 12.1.10**, **12.1.11** and **12.1.14**.

  <u>Overall very significant short-term negative visual impact</u>

- **Landscape Planning:** The historic settlement of Coolagh-Briarhill Village lies to the immediate northeast of the proposed road development. This village already overlooks existing smaller N6 junction.

  The landscape surrounding Ballybrit is designated for Recreation and Amenity land use.

  <u>Overall significant short-term negative landscape planning impact</u>

- **Landscape Character:** Construction of proposed embankments, cuttings and structures will have a substantial impact on the open recreational and amenity character of Galway Racecourse.

  <u>Overall significant negative impact on local landscape character</u>

12.5.3.6 Visual Impact

Visual impact tends to be most pronounced during the construction phase when the initial disturbance is both unfamiliar and substantial and may often be in close proximity to properties. At the same time, effective visual mitigation may also be limited and therefore, significant negative temporary and short-term visual impacts will arise.

Construction stage impacts will arise primarily from visual disturbance and visual intrusion resulting from the initial loss of vegetation and boundary screening, from earthworks, alteration of ground levels and from normal construction activity and traffic. Issues such as noise and construction activity and the location of construction compounds will also have the effect of drawing visual attention to the works, thereby increasing the perceived visual impact associated with visual disturbance.

The construction stage visual impact of the proposed road development has been assessed and is set out in detail in the Visual Impact Schedule (VIS) Table in **Appendix A.12.1**. The findings are summarised in **Table 12.5** below.

In overall terms, some 406 locations have been assessed along the proposed road development. Of these 54 residential properties will be acquired (44 of which will be demolished), together with a temporary acquisition of the NUIG Sports Pavilion, and the remaining 352 properties and landscape locations have been assessed for visual impact during construction. Refer to **Chapter, 15 Material Assets – Non Agriculture** for further details on acquisitions.

During the construction stage, 36 of the 352 locations (c.10%) will have an imperceptible impact. A further 169 locations (c.49%) will have a not significant, slight or moderate short-term impact. One hundred and five locations (c.30%) will have significant or very significant short-term visual impact. The remaining 42 locations (c.11%) will experience profound temporary or short-term negative visual impact associated with the construction stage of the proposed road development.

Table 12.5: Visual Impacts Construction Stage

Impact	Construction Stage
Imperceptible	36
Not Significant/Slight	79
Moderate	90
Significant	80
Very Significant	25
Profound	42
Total	352

12.5.4 Potential Operational Impacts

Potentially impacted features and general landscape and visual impacts are described on a section by section basis in the following. An assessment of the overall operational stage visual impact is also discussed separately in the **Section 12.5.4.6**.

12.5.4.1 Ch. 0+000 to Ch. 6+300 (Landscape Character Area 9)

- **Landscape Character:** In its operational phase the proposed road development, with its various sections of embankment and related road infrastructure will contrast significantly with the open exposed nature of the existing landscape, the small-scale and narrow nature of existing roads and the extent of residential development located along such existing roads. The proposed road development will tend to integrate over time within this generally small scale coarse landscape.

  Lighting at the proposed R336 Coast Road and lighting from traffic will also introduce a significant new element into the landscape corridor of the proposed road development. The corridor of the existing R336 – especially along the northern side – is being increasingly developed resulting in an on-going change to its background rural character.

The introduction of short sections of roadside lighting at the proposed Bearna East Roundabout and the proposed Cappagh Road Junction will also accentuate the degree of change in the background rural landscape. Roadside lighting at the proposed Ballymoneen Road Junction will tie-in to existing roadside lighting to the immediate south along the Ballymoneen Road.

Local significant short-term and locally moderate medium-term negative impact

- **Visual Impacts:** Significant negative visual impacts will continue to arise for residential properties close to the proposed road development, especially in the crossing of local roads (at R336, Foraí Maola, Troscaigh, Ann Gibbons, Aille, Cappagh, Ballymoneen, Rahoon and Letteragh) and Troscaigh/Foraí Maola Overbridge Link. Refer to **Section 12.5.4.6** and **Figures 12.1.01** to **12.1.05**.

  Overall significant short-term and locally moderate medium-term negative impact

- **Landscape Planning:** The proposed road development will have a significant impact on the Green Wedge and Environmental Management Zone located along the Sruthán Na Libeirtí, in that it impacts on a substantial portion of the designations. Nevertheless, the most significant portion of the designations are retained along the more sensitive corridor of Sruthán Na Libeirtí. The proposed road development will not have a significant impact the Environmental Management Zone at either the Trusky Stream (Ch. 2+850).

  The proposed road development will not have a significant impact on the proposed large areas of open spaces east of Aille Road (Ch. 3+850); and at Cappagh/Ballynahown/Keeraun (c.Ch. 4+700 to Ch. 5+300).

  The proposed road development will not have a significant impact on proposed greenway link objectives. The proposed road development will allow for and facilitate crossing and tie-in to proposed greenway link objectives at Trusky Stream (Ch. 2+850); at Aille Road (Ch. 3+300) and at Cappagh Road (Ch. 4+450); Boleybeg Bóithrín (Ch. 4+550) and at Keeraun Bóithrín (Ch. 5+950).

  While traffic on the proposed road development will introduce a moving and distracting element within the foreground of protected views 72 and 74, it will not detract from the longer-range focus of the views – which is the sea and the north Clare coast. In addition, the proposed road development will open up significant new views of the coast and the sea – especially travelling from Na Foraí Maola Thair, south to the R336.

  Moderate short-term and slight medium-term negative landscape planning impact

12.5.4.2 Ch. 6+300 to Ch. 8+000 (Landscape Character Area 12)

- **Landscape Character:** In its operational phase the proposed road development, with its various sections of embankments and cuttings (latter especially at Ballagh/Bushypark) and major junction at Letteragh will contrast significantly with the open exposed, sometimes remote and elevated nature of the existing landscape and the small-scale and narrow nature of existing roads. Residential development is prominent along local existing local roads and the area is increasingly under the influence of expanding city development. The proposed road development will tend to integrate over time within this increasingly urban influenced landscape.

Roadside lighting at the proposed N59 Letteragh Junction and along the proposed N59 Link Road North together with lighting from traffic will also introduce a significant new element into the landscape corridor of the proposed road development.

Roadside lighting is already present on the N59 Moycullen Road at the location proposed N59 Bushypark Junction. Likewise roadside lighting is already present between Gateway Retail Park – Rahoon Road – Rosán Glas – Bun A Chnoic, which accounts for much of the corridor of the proposed N59 Link Road South.

<u>Significant short-term and moderate medium-term negative impact on local landscape character</u>

- **Visual Impacts:** Significant negative visual impacts will continue to arise for residential properties, especially in the crossing of local roads at Letteragh and Rahoon and at tie-in to existing N59 Moycullen Road at Ballagh/Bushypark). Refer to **Section 12.5.4.6** and **Figures 12.1.05** to **12.1.06** and **Figures 12.1.12** to **12.1.13**.

  <u>Overall significant short-term and moderate medium-term negative visual impact</u>

- **Landscape Planning:** The proposed road development falls within the context of Linear View 10 of the River Corrib from the N59 Moycullen Road and County View 76 of Lough Corrib from the Ballagh/Bushypark area. However, the proposed road development will not detract from the focus of the protected views (River Corrib and Lough Corrib) from these locations.

  <u>Slight short-term negative and no medium-term landscape planning impact</u>

12.5.4.3 Ch. 8+000 to Ch. 11+800 (Landscape Character Area 11)

- **Landscape Character:** The proposed road development, including major new c.650m long bridge, high embankments and a c.320m long viaduct will introduce a dominant new feature into its landscape corridor. The new bridge will be prominent along the River Corrib and NIUG Sports Campus and from Menlo Castle, while the embankments and viaduct on the east of the River Corrib cross a very remote and elevated semi-natural landscape. The bridge and viaduct, and particularly traffic on the structures, will also be visible where elevated vantage points on the west side of the river allow for viewing across the River Corrib valley.

  Given the existing environment, and the nature of this section of the proposed road development, integration of the development will be slow and structures such as the bridge and viaduct will permanently influence landscape character.

  Other than at the portal entrance to Lackagh Tunnel and within Lackagh Quarry itself, is not proposed to provide roadside lighting along this section of the proposed road development. Nevertheless, a level of lighting will be introduced from traffic movements particularly along elevated sections. Floodlight facilities will also to be provided in association with the proposed all-weather sports pitch at NUIG Sports Campus. The floodlighting will allow for evening use of the facilities during darker evening months and will not have extended or night-time use.

<u>Profound short-term and very significant medium negative impact on local landscape character</u>

- **Visual Impacts:** Profound negative visual impacts will continue for residential properties, especially to either side of N59 Moycullen Road; through NIUG Sports Campus; at crossing of River Corrib, including at Menlo Castle; as well as at Bóthar Nua and Seanbóthar on east bank of River Corrib. Many properties are retained close to the elevated proposed road development both east and west of the N59 Moycullen Road (Ch. 8+300 to Ch. 8+700). This necessitates the use of retaining walls to minimise landtake and the presence of retaining structures will increase the visual impact of the development in these areas. Noise barriers are also provided along sections of the proposed road development. Whilst they will screen traffic, where they are located on the top of an embankment they will also accentuate the overall visual impact. The proposed noise barriers on the River Corrib Bridge will be transparent. Refer to **Section 12.5.4.6** and **Figures 12.1.06** to **12.1.08**.

  <u>Overall profound short-term negative visual impact and very significant medium-term impact</u>

- **Landscape Planning:** The proposed road development crosses recreation and amenity zoned lands on west bank of River Corrib; the river itself and High Amenity Agricultural lands on east bank. While this will change the character of the area the proposed road development will not preclude on-going objectives for the landscape planning of the area.

  The river crossing is not significant within the context of protected County View 76 of Lough Corrib from the Dangan area.

  <u>Significant short-term and moderate medium-term negative landscape planning impact</u>

12.5.4.4 Ch. 11+800 to Ch. 14+200 (Part of Landscape Character Area 11 as well as Landscape Character Area 5)

- **Landscape Character:** The proposed road development, which includes two major junctions (N84 Headford Road and N83 Tuam) and significant embankments and cuttings cuts across a rolling drumlin valley landscape and is within the wider setting for Ballindooley Lough. Traffic on elevated embankments will be particularly prominent from higher ground further east/northeast. Nevertheless, the landscape corridor of the proposed road development is also being increasingly influenced by urban edge development – especially along the N84 Headford Road and N83 Tuam Road.

- This section includes for the introduction of significant extent of proposed roadside lighting across an area, which is currently outside the limit of roadside lighting in adjoining suburban areas. Notwithstanding proximity to the developed suburbs, roadside lighting, as well as lighting associated with traffic, will have the effect accentuating the presence of the proposed road development and emphasising the degree of change in the background rural/suburban edge landscape.

<u>Significant short-term and moderate medium-term negative impact on local landscape character</u>

- **Visual Impacts:** Very significant/profound negative visual impacts will continue for residential properties, especially to east of the crossing on Headford Road and through Castlegar generally. Refer to **Section 12.5.4.6** and **Figures 12.1.08** to **12.1.10**.

  <u>Profound short-term and very significant medium-term negative visual impact</u>

- **Landscape Planning:** Impact will arise for the high amenity setting of Ballindooley Lough and from the historic village settlement of Castlegar.

  The proposed road development will not have a significant impact on protected views V6 and V19.

  <u>Significant short-term and moderate medium-term negative landscape planning impact</u>

12.5.4.5 Ch. 14+300 to Ch. 17+540 (Landscape Character Area 3)

The following operation-related aspects give rise to potential for landscape and visual impacts within this section of the proposed road development:

- **Landscape Character:** This section of the proposed road development is set within an urban influenced landscape. Nevertheless, the significant road infrastructure will give rise to impacts on local character – especially through the open recreational and amenity character of Galway Racecourse and to a lesser degree at Dougishka and Coolagh-Briarhill – which are already impacted by the existing N6 and city development.
- While roadside lighting is proposed through this area, much of the area already lies within the suburban context of the outer city where roadside lighting is a feature of the background landscape.

  <u>Significant short-term and slight medium-term negative impact on local landscape character</u>

- **Visual Impacts:** Very significant negative visual impacts will continue for residential properties at Racecourse Avenue/Ballybrit Crescent and to a lesser degree at Coolagh-Briarhill. Refer to **Section 12.5.4.6** and **Figures 12.1.10** to **12.1.11** and **12.1.14**.

  <u>Very significant short-term and moderate medium-term negative visual impact</u>

- **Landscape Planning:** Proposed road development passes through the edge of the recreation and amenity zoned landscape of Galway Racecourse and to the west and south of the historic village settlement of Coolagh-Briarhill Village already overlooks existing smaller N6 junction.

<u>Moderate short-term and slight medium-term negative landscape planning impact</u>

12.5.4.6 Visual Impact

On completion of construction, aspects such as earthworks, construction activity and disturbance are removed as impacting features. Nevertheless, impacts will continue to arise from the presence of the proposed road development which will remain prominent in the landscape until such stage as landscape proposals established and become effective. As such, operational-stage visual impacts will be most pronounced in the short-term after construction (*i.e.* pre-establishment stage), however, negative visual impact will also continue to arise for residential and other properties located close to or adjoining the boundary of the proposed road development for some considerable period of time (*i.e.* post-establishment stage).

During the operation stage, visual impacts will continue to arise from the physical built presence of the proposed road development, including its significant structures, elevated embankments, deep cuttings, traffic usage and additional illumination both fixed and from vehicles, especially where the proposed road development is on embankment or at junctions and bridging locations. In open views, embankments have the potential for visual obstruction and significant visual intrusion. Deep cuttings can also result in significant change to the visual nature of landscape continuity.

Measures for the mitigation of potential noise impact will be required at a number of locations along the proposed road development, especially where residential properties are in close proximity to the carriageway. Such noise impacts and mitigation measures are considered in detail in **Chapter 17, Noise and Vibration**. Mitigation measures will involve the provision of barriers or earth bunds or a combination of such features. While initially these features may increase the visual presence of the proposed road development, they also provide for immediate visual screening of the proposed road development and its associated traffic. In the majority of circumstances these features can also be appropriately incorporated into the proposed landscaping measures.

The proposed road development also includes for realignments/tie-ins to existing national, regional and local roads, together with drainage works and accommodation measures, all of which have potential for localised visual impacts. Local road realignment is important as many residential properties tend to be located along such roads and local direct impacts can arise.

A full schedule and description of visual impacts on properties is set out in the Visual Impact Schedule (VIS) Tables in **Appendix A.12.1** and on **Figures 12.1.01** to **12.1.14**. The findings are summarised in **Table 12.6** below.

In the pre-establishment stage 71 of the 352 locations (c.20%) will have an imperceptible impact. A further 166 locations (c.47%) will have a slight or moderate short-term impact. Eighty-five locations (c.24%) will have significant or very significant short-term visual impact. The remaining 30 locations (c.9%) will experience profound short-term negative visual impact associated with the presence and early operation stage of the proposed road development. Refer to **Figures 12.1.01** to **12.1.14** for locations of properties.

As landscape measures establish and mature the level of visual impact will gradually recede so that in the post-establishment stage some 152 locations (c.43%) will have an imperceptible impact. A further 145 locations (c.41%) will have a slight or moderate medium-term impact. Thirty-two locations (c.9%) will have significant or very significant medium-term visual impact. The remaining 23 locations (c.7%) will continue to experience profound medium and longer-term negative visual impact associated with the proposed road development. Refer to **Figures 12.1.01** to **12.1.14** for locations of properties.

The properties with on-going significant and very significant visual impact are either located in more remote and rural areas and are in proximity to the proposed road development, or are in suburban areas and are located directly adjacent to the proposed road development.

Table 12.6: Summary of Visual Impacts

Impact	Construction Stage	Pre-establishment Stage	Post-establishment Stage
Imperceptible	36	71	152
Not Significant/Slight	79	82	74
Moderate	90	84	71
Significant	80	67	32
Very Significant	25	18	0
Profound	42	30	23
Total	352	352	352

12.5.4.7 Photomontages

Photomontages have been prepared of the proposed River Corrib Bridge and for other areas along the route of the proposed road development.

The Photomontages of the proposed River Corrib Bridge and associated infrastructural works from the surrounding landscape are included in **Appendix A.12.2**. For some locations the views are summer-time, for others the views are winter-time and for some locations both summer and winter views are used. In any case, it is clear that the density of vegetation in the local landscape means that the potential for increased winter-time visibility is not so pronounced in this landscape setting.

For each view three options are presented starting with the ‘As Existing’ view. Thereafter, a view is shown with the proposed road development simply ‘overlaid’ on the existing view. This assists the viewer in accurately locating the proposed road development in the view before it is set into the image. The final version is an ‘As Proposed’ view and this shows what, if any, of the proposed road development will be visible.

A feature of all of the more distant views is the extent to which the landscape visually absorbs the proposed road development and bridge. This characteristic ensures that the proposed road development will not dominated views within its wider landscape setting. As such the proposed road development and bridge is either entirely screened or only partly glimpsed in views from Quincentenary Bridge (View 1); from the Coolough-Menlough Road (Views 2, 3 & 4); from Glenlo Abbey (View 8); and from the N59 Moycullen Road in the vicinity of Bushypark House (Views 9, 10, 11 & 12); and from more southern parts of the NIUG Sports Campus (View 15).

The bridge becomes an increasingly prominent feature in closer range views, especially from the river bank (Views 6, 7, 16, 20, 21 & 22); from Menlo Castle (Views 5, 6, 20 & 21); and from the grounds of NUIG Sports Campus (Views 14, 16, 17, 18, 19). That said the wooded nature of the background river edge landscape means that the structure appears out of a wooded backdrop to openly cross the wide river in a simple single span. The effect is to maintain open views along the river corridor and to/from Menlo Castle.

The greatest impact is from the existing sports grounds of NUIG on the west bank of the river where users of the sports facilities and the river-side amenities gain direct access to the underside of this large structure.

Photomontages have also been prepared from a range of other areas along the route of the proposed road development. These views, which are included in **Appendix A.12.3**, are presented in two formats: first showing landscape works immediately after planting and second: with established planting c.15 years after planting. The views help illustrate the nature of the physical and visual changes, as well as the associated effects likely to arise as a result of the proposed road development.

12.5.5 Landscape and Visual Impact of related or associated developments

Other aspects of the construction and operation of the proposed road development have potential for landscape and visual impacts. Construction-related aspects such as site compounds, construction traffic on the local roads, temporary road closures and diversions, works associated with local road tie-ins, provision of footpaths and cycleways, stream diversions, culverts, drainage works, drainage ponds, service diversions, including diversion of overhead transmission lines will give rise to slight to moderate localised temporary impacts.

ESB’s 110kV overhead transmission lines are to be locally modified and/or diverted at four locations namely Cappagh, Castlegar, Parkmore, and Coolagh, Briarhill, as indicated on **Figures 15.1.1** to **15.1.15** (e.g. Ch. 13+525; Ch. 14+200 to Ch. 14+450 – Parkmore Link Road Junction; Ch. 16+20 to Ch. 17+100 – Coolagh Junction). These minor modifications/diversions will give rise to imperceptible to slight landscape or visual impacts.

Minor adjustments, including short re-alignments, undergrounding, provision of new poles and local raising of existing low voltage transmissions lines (10kV, 38kV) is also proposed at a number of locations as indicated on **Figures 15.1.1** to **15.1.15** (e.g. Ch. 3+780; Ch. 3+875; Ch. 6+675; Ch. 8+250 to Ch. 8+500; Ch.

2+025 – N59 Link Road South & Parkmore Link Road). These will not give rise to adverse landscape or visual impacts. Refer to **Chapter 15**, **Material Assets Non-Agriculture** for further details.

As well as the mainline, the proposed road development will involve the construction of roundabouts, at-grade junctions, grade-separated junctions, local roads, tunnel service buildings and a c.30m wide wildlife overbridge at Castlegar (Ch. 12+700).

East of the River Corrib roadside lighting is to be provided at the main junctions between the R336 Bearna West Roundabout and the N59 Letteragh Junction; along the full length of the N59 Link Road South, including around the Gateway Retail Park Junction; along the full length of the N59 Link Road North, including at the Bushypark Junction on the N59 Moycullen Road. Roadside lighting is already present along the part of the corridor of the N59 Link Road South between Gateway Retail Park – Rahoon Road – Rosán Glas and Bun A Chnoic. Roadside lighting is also already present along the N59 Moycullen Road at Bushypark.

West of the River Corrib roadside lighting is to be provided at the Lackagh Tunnel Portal; along the full length of the mainline of the proposed road development from Lackagh Tunnel, via the N84 Headford Road Junction to the N83 Tuam Road; along the City North Business Park Link; the Parkmore Link Road; at the Galway Racecourse Tunnel Portals; and along the Briarhill Business Park Road, the Ballybrit Crescent Junction, the R339 Monivea Road, Lynch Junction, Briarhill Link, Coolagh Junction and section of R446 within the proposed road development. Roadside lighting is already present along the N83 Tuam Road, within Parkmore Business Park, along Ballybrit Crescent, along R339 Monivea Road, along Briarhill Business Park Road, and along Bóthar na dTreabh, at the Coolagh Roundabout, and for 300m east along the existing N6.

Where not already a feature of the landscape, the introduction of roadside lighting will emphasise the degree of change in the rural landscape brought about by the proposed road development and associated traffic use. In many central and eastern areas the proposed road development passes through a suburban or suburban edge landscape where roadside lighting is already a feature. The most significant area of additional roadside lighting runs from Lackagh Quarry east to the proposed N83 Tuam Road Junction.

Operational aspects such as gantries and other signs, lighting columns, noise barriers, safety barriers, boundary and other fencing are all features typical of road development. In general, such aspects will give rise to slight localised and short-term impacts, however, taller noise barriers (>2.5m) on elevated sections of embankment located to either side of the N59 Moycullen Road crossing will further accentuate already significant visual impact for residential properties in this area. Where present, noise barriers will also have a beneficial effect in reducing the visibility of traffic from nearby residential properties. Transparent noise barriers will be used on the proposed River Corrib Bridge. Tunnel service buildings are to be provided adjacent to the two tunnels at Lackagh Quarry (Ch. 11+300) and Galway Racecourse (Ch. 14+950). The former building is to be located within the excavated quarry floor and will have no landscape or visual impact. The latter building is to be provided close to the boundary with Racecourse Business Park, where it will not give rise to landscape or visual impact. Likewise, the proposed re-organised stabling and parking at Galway Racecourse is in keeping with the surrounding context and will not give rise to adverse landscape or visual effects. Tunnel portals are associated with the two tunnels – however, these features are set into the landscape (as in Lackagh Quarry) or set low in the landscape (as at Galway Racecourse). The proposed wildlife overpass at Castlegar (Structure S12/02, Ch.12+700) will provide a wide landscape/planted bridge for connection of local habitats. The proposed new sports pitches at NUIG Sports Campus are located on existing pitches and while floodlighting is also to be provided, this is not out of place in the context of the surrounding sport campus.

12.6 Mitigation Measures

12.6.1 Introduction

Consideration was given to avoidance of significant landscape and visual impacts during the route corridor selection and during the design process for the proposed road development. Nevertheless, all road construction projects give rise to some degree of unavoidable landscape and visual impacts.

Mitigation of landscape and visual impacts for the proposed road development shall have regard to the approach as set out in the following NRA/TII guidance documents:

- Guidelines for the Creation and Maintenance of an Environmental Operating Plan (2007)
- A Guide to Landscape Treatments for National Road Schemes in Ireland (2006)
- Guidelines on the Implementation of Landscape Treatments on National Road Schemes in Ireland (2012)
- Guidelines for the Protection and Preservation of Trees, Hedgerows and Scrub Prior to, During and Post Construction of National Road Schemes (2006)
- Guidelines on the Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads (Revision 1, 2010)
- Standard Construction Details (2000-2017)
- Specification for Works (2000-2017)

In the following sections detailed mitigation proposals are set out for both the Construction Stage and Operational Stage

Landscape mitigation proposals shall take account of the approaches and principles as set out in A Guide to Landscape Treatments for National Road Schemes in Ireland, in particular to Chapter 4: Components of the Roadside Landscape; Chapter 5: Soil Geographic Factors; and Chapter 6: Landscape Treatments. Unless otherwise qualified in the following or in **Chapter 8, Biodiversity**, seeding and planting proposals, including species and planting type and species shall be in accordance with Chapter 6 of the Landscape Guidelines, adapted as required for local environmental and landscape conditions.

12.6.2 Construction Phase

During the construction stage, the Construction Environmental Management Plan (CEMP) in **Appendix A.7.5** will be finalised and adopted by the Contractor'. Adherence to the CEMP will be a contract requirement and this will ensure good working practices are followed so as to minimise and manage any significant, negative environmental impacts arising from construction. As well as other items, the CEMP includes the mitigation set out within this chapter and incorporates these measures as part of their implementation.

Mitigation will ensure that the works will have continuous monitoring under the Construction Environmental Management Plan so as to ensure adequate protection of areas outside of the construction works.

Specific measures shall ensure that:

- Site machinery shall operate within the proposed road development construction area
- Storage areas shall be located so as to avoid impacting further on existing residential and other property, woodlands, trees, hedgerows, drainage patterns, etc.
- Solid site hoarding of minimum 2.0m in height shall be provided alongside construction works adjoining residential property or recreational amenities
- Solid hoarding or similar, of minimum 2.0m in height shall be provided along any side of a proposed construction compounds, where they are located within 100m of residential properties
- Construction compounds shall be fully-decommissioned and reinstated to their pre-construction condition at the end of the construction contract
- Side slopes and other landscape areas along the proposed road development shall be prepared for soiling, and either seeded and/or planted at the earliest possible opportunity. As such, some scope may exist for undertaking significant areas of seeding and planting prior to the end of the construction works. However, due to construction programming and seasonal restrictions, it is also likely that significant planting works will not be undertaken until the end of the major construction phase

12.6.3 Operational Phase

Measures proposed to mitigate the landscape and visual impacts of the operation stage of the proposed road development are considered under Project-wide Measures and Specific Measures. Project-wide measures are described in the following section and in **Table 12.7**, while specific measures are set out in detail in **Table 12.8**. The measures are also identified on **Figures 12.4.01** to **12.4.14**.

12.6.3.1 Project-wide Landscape Measures

Project-wide measures will be applied over the entire proposed road development, depending on the nature of the particular road section. Where feasible such measures shall include for the re-connection of existing field boundaries and hedgerows along the proposed road development. Where appropriate trees species as noted in Mitigation **Tables 12.7** and **12.8**, shall be randomly spaced in a visually naturalistic manner within such hedgerows.

This approach will be locally modified to incorporate other landscape treatments, which may negate the requirement for the hedgerow, *e.g.* blocks of native woodland planting (see Landscape Guidelines, Section 6.2: Tree and Shrub Treatments) or semi-natural meadows (see Landscape Guidelines, Section 6.1: Grassland Treatments) where it is considered appropriate to have open sections along the proposed carriageway. Open sections shall allow for views to the wider landscape where they do not impinge on requirements for screening for residential properties or other amenities.

Proposals will ensure that planting is distributed along the proposed road development and the associated local road realignments and will vary from locally appropriate hedgerow reinstatement, with tree-planting, where appropriate; to wider plantings of landscape and screen planting; to the establishment of larger areas of scrub/shrub planting and new woodland for integration of the development within the wider landscape. The approach will provide a density and diversity of plantings and improve the biodiversity structure of the new landscape (see Landscape Guidelines, Section 6.2: Tree and Shrub Treatments).

Treatments will take into consideration the assessment and recommendations of **Chapter 8, Biodiversity** and will ensure that, species which are locally indigenous and native are utilised in the proposed plantings. However, detailed proposals in terms of their nature and approach will consider the locally impacted environment and in terms of species may include non-invasive, non-native plants, *e.g.* within residential areas where existing garden plantings are disturbed.

Where areas are in cut or fill, a grass or meadow sward will be established over the slope except in areas of cutting through stable rock (see Landscape Guidelines, Section 4.2: Cuttings and Embankments). It is not proposed to plant either cut or fill slopes in their entirety, but to encourage a more naturalistic and locally sympathetic grouping of plantings within a semi-natural grass sward. Slopes may also be seeded to wildflower grassland and hydro-seeding may be utilised for seeding of steep slopes. It is expected that significant extent of rock cutting will arise on the proposed road development. Stable rock slopes will be retained as an exposed face for natural colonisation and as a local landscape features.

Along the length of the proposed road development, landscape areas within junctions and small areas of severed fields, plots or other property acquired for the construction of the proposed road development will be varyingly treated including being planted in a semi-natural copse like scrub plantings and native woodland species (see Landscape Guidelines, Section 4.6: Additional Plots and Other Areas). Such planted blocks dispersed along the proposed road development will assist in the improvement of the longer-term visual character of the proposed road development and local surrounds. Particular attention shall be given to an appropriate extent and scale of planting in and surrounding junctions (see Landscape Guidelines, Section 4.3: Junctions, Interchanges and Roundabouts) and embankments (see Landscape Guidelines, Section 4.2.2: Embankments).

Certain areas along the length of the proposed road development have been set aside for drainage requirements/pollution control/attenuation. Where proposed these will be securely fenced and planted with locally appropriate hedgerows, shrubs and/or screen planting located along the proposed development boundary to minimise any visual impact from off road areas. However, it is noted that these features also offer the potential to provide for improved landscape diversity and habitat.

Proposed planting will generally be established using bare-root transplants, whips and feathered plants which adapt readily to disturbed ground conditions. A proportion, totalling not less than 5% of 'Half-standard' (6-8cm girth & 200cm-250cm tall) and a further 5% 'Standard' (8-10cm girth & 250cm-300cm tall) trees shall be used to supplement these plantings, especially in the vicinity of residential areas. All planting mixes will take cognisance of, and include native and local species as identified in the **Chapter 8, Biodiversity**. These requirements have been adapted and further detailed as appropriate to particular areas as set out in **Table 12.8**.

Where used, tree species will be selected from a list of primarily native, naturalised and indigenous species, which will include alder, common ash (*subject to planting restrictions at time of works*), common birches, common oaks, mountain ash, Scots pine and willow species. Planting sizes will be from 75cm to 400cm in height and tree species will be planted at average 2.0m centres within the wider planting mix.

Shrub planting species utilised will be selected from a list of primarily native and indigenous species, which will include, blackthorn, elder, hawthorn, hazel, holly, guelder rose, spindle, willows and other plants found naturalised in the affected localities. Planting sizes will vary from 30 to 75cm in height and shrub species will be planted at between 1.0 and 1.5m centres depending of landscape type, see **Table 12.8**.

Hedge planting will be primarily of blackthorn and hawthorn interspersed with other species such as elder, hazel, holly and those found locally. Hawthorn within hedgerows shall be planted at between 75 to 90cm in height and at 500mm centres in each of 2 double staggered rows or wider plantings where a more dense effect is required. The hedgerow will be interspersed with standard-sized randomly spaced tree species such as alder, common ash and oaks, as appropriate to particular locality.

Areas to be seeded to meadow will be thinly topsoiled (5cm layer) and seeded with a locally appropriate seed mix. Mainline and side road verges will be cultivated, topsoiled minimum 200mm deep and stone buried to remove stones down to 25mm diameter prior to seeding to a low-maintenance grass seed mix.

Where lighting is proposed, the lighting design shall meet the requirements of BS EN 13201-2:2003 and BS5489-1: 2003, Code of Practice for Design of Road Lighting. Lighting of Roads and Public Amenity Areas and shall comply with the requirements of the DMRB TD 34-91. The detailed lighting design shall be completed in a manner, which will minimise glare and will ensure that light-spill effect is minimised.

In specific locations barriers and/or earth bunds may be provided to reduce the impact of noise. Such barriers will also have the effect of providing immediate visual screening of traffic from properties. Such features shall, wherever possible, be integrated within the proposed landscaping measures. **Chapter 17, Noise and Vibration** outlines the assessment of noise impact and the requirements for such mitigation.

Table 12.7: Project-wide Landscape and Visual Mitigation Elements and Treatments (Note Proposed Road Development has been abbreviated to PRD in the following table)

Reference	Description of Measures
Cut slopes on mainline, link roads and local roads	Cut slopes shall be finished to even gradients, topsoiled unless otherwise stated in this table or elsewhere in the EIAR. Slopes shall be free of rubble and stones over 50mm diameter. All such rubble/stone shall be removed or buried. Unless otherwise stated slopes shall be seeded to a low maintenance non-agricultural grassland or to a diverse grass/wildflower sward, as appropriate. Steep slopes may be hydro-seeded. Where exposed, stable rock cuttings / slopes will be retained as a landscape feature along the proposed road corridor.
Embankments on mainline, link roads, and local roads	Embankments shall be finished to even gradients, topsoiled unless otherwise stated in this table or elsewhere in the EIAR. Slopes shall be free of rubble and stones over 50mm diameter. All such rubble/stone shall be removed or buried. Unless otherwise stated slopes shall be seeded to a low maintenance non-agricultural grassland or to a diverse grass/wildflower sward, as appropriate. Steep slopes may be hydro-seeded.
Verges & Roundabouts on mainline, link roads, and local roads	Verges will be provided along both sides of mainline. Verges will also be provided around junctions and along local road re-alignments and tie-ins. Verges and roundabouts shall be finished to even or gently flowing gradients, with minimum 200mm topsoil. Areas shall be stone buried or raked will be free of rubble and stones over 25mm diameter. Verges and roundabouts will be seeded to low-maintenance seed mix.
Ponds, swales, 'V-drains' etc.	All slopes shall be evenly graded and free of rubble and stones over 50mm diameter. Slopes shall be seeded to low maintenance non-agricultural grassland or to a grass/wildflower sward, allowing for natural development over time. Steep slopes on pond edges and 'V-drains' may be hydro-seeded. Areas around ponds shall be a diverse landscape of low maintenance grassland/species-rich grass wildflower sward and plantings of scrub planting and/or low-canopy woodland and shrub planting. Hedgerows of blackthorn and hawthorn, hazel

Reference	Description of Measures
	and holly, without tree species, shall be established along non-roadside boundaries. Non-palisade type fencing (*e.g.* paladin or timber and anti-climb netwire fencing) shall be secure pond areas.
Noise barriers / bunds	Where possible hedgerow scrub and shrub planting and/or low-canopy woodland of native species shall be established as either a narrow planting of 3.0m minimum width or double-staggered hedgerow along the full off-road face of barriers. Low-canopy and/or shrub planting of native species shall be established on the off road face of bunds. The planting shall include ash*, birch, blackthorn, elder, hawthorn, hazel, holly, rowan and/or willow species as appropriate. Plants shall be 90 to 120cm in height at planting. *** Note**: Due to the risk of Ash Dieback (*Chalara fraxinea*) and until further notice, ash (*Fraxinus* species) is no longer approved by the TII for planting schemes. This does not impact on the use of Mountain ash – also known as rowan (*Sorbus aucuparia*). Transparent noise barriers will be used on the River Corrib Bridge
Plants and planting areas	All tree species over 150cm in height together with all Pine shall be appropriately staked and tied. All failed, dead or defective plants shall be replaced before the end of each and every year of defect aftercare. Full planting area will be free of stones over 50mm in diameter.
Grass areas	Grass areas shall provide full sward cover within 12 months of seeding. Any failed, bare or defective areas shall be re-seeded between March – May and/or August – September in each and every year of defect aftercare.
Unauthorised access, parking and/or encampment	Landscape proposals shall avoid creating areas considered as being suitable for unauthorised parking and shall use landscape proposals to deter and prevent such use.
Remnant areas	Any post-construction remnant lands shall be treated to a diverse range of grassland and/or planting proposals to include a minimum 30% planting, amended as locally appropriate. The remaining area shall be treated as locally appropriate low maintenance grass/species-rich sward.

12.6.3.2 Specific Landscape Measures

Specific mitigation measures are set out on **Figures 12.4.01** to **12.4.14** and in **Table 12.8**. The measures include construction-related aspects such as avoidance/minimising impact on property boundaries and landscape features as well as provision of solid screen hoarding during the construction phase for those properties particularly impacted by the works.

All of the following specific mitigation measures will be taken account of in the detailed design and implementation of landscape measures:

- Location of cut-off drains at the top of cuttings and at the bottom of embankments
- The location and requirements for maintenance access along the mainline of the proposed road development
- Locations where rock is encountered in cuttings. Such rock faces may be retained as geological features of the corridor of the proposed road development
- The location and integration of noise barriers within the landscape design
- Clearance zones (TD19 - Safety Barrier Standards)
- Sight-lines, including at junctions and to carriageway signage, *etc*.

A series of significant retaining walls, and a bridge over the N59 Moycullen Road, are proposed in the Dangan area between Ch. 8+300 and Ch. 8+670. This is both an existing residential area and a gateway into the city. Where feasible reinforced earth retaining wall approaches will be incorporated so as allow for a green landscape finish to all or part of the retaining structures. A limestone finish will be used where structural walls are required and for the abutments of the proposed bridge over the N59 Moycullen Road. The stone will consist of natural limestone, matching the character of the local stone, with a strong horizontal axis of between 5 to 1 and 7 to 1 (*i.e.* horizontal to vertical dimension).

Landscape Measures also take account of the specific protection and mitigation measures detailed in **Chapter 8, Biodiversity**. In particular, the measures include:

- Retained habitats, trees and hedgerows on land-take boundaries, *etc*. will be fenced-off and protected during construction works
- Specific measures are proposed at a number of locations for mitigation of potential impact on Bat species. This includes:
    - the provision of artificial bat roosts – with specific planting to encourage use
    - the provision of a planted wildlife overbridge (Ch. 12+700) with tie-in planting to local hedgerows and proposed planting on the boundary of the proposed road development, which will maximise potential benefit and use
    - dense planting, with trees for improvement of connectivity along the boundary of the proposed road development:
        - west of the crossing of the L1323 Letteragh (Ch. 7+200 – Ch. 7+280)

    - along embankments to either side of the proposed bridge over the River Corrib
    - between the crossing of the N84 Headford Road at Ballindooley and School Road at Castlegar
  - hedgerow planting for improvement of connectivity of habitats to the east of Menlo Castle
  - hedgerow and copse planting for enhancement of foraging habitat to the north of Menlo Castle
- In order to deter Barn Owls from foraging close to the proposed road development, embankments and cuttings, other than rock cuttings or cut slopes left to naturally regenerate, will be densely planted with low growing scrub (e.g. blackthorn, hawthorn) from Ch. 8+550 to Ch. 17+500
- In order to deter Barn Owls from over flying the proposed road development, planting of closely-spaced trees (approx. 2m centres) greater than 3m in height will be established along the top of the embankments between Ch. 9+600 and Ch. 10+100
- All mitigation planting will take place at the earliest opportunity feasible during the construction stage so as to maximise establishment prior to road opening

Table 12.8: Specific Landscape and Visual Mitigation Elements and Treatments
(Note Proposed Road Development has been abbreviated to PRD in the following Table)

Reference	Location	Description of Measures
6.0m wide Screen Planting	Planting at 1.0m centres for visual screening shall be of a minimum of 6m in width. The planting shall extend for a minimum of 100m to either side of any adjoining residential property or amenity. (refer to **Figures 12.4.01** to **12.4.14**)	Planting will include a dense planting at 1m centres of alder, birch, blackthorn, elder, geulder rose, holly, hawthorn, hazel, rowan, and willow species. Shrubs shall be planted at between 60 to 90cm in height. Scots pine of minimum 60cm in height at planting shall comprise 20% of the overall plant numbers and holly at a minimum of 45cm in height shall comprise a further 15%. Tree species, planted equally at half-standard (6-8cm girth) and standard size (8-10cm girth), shall comprise minimum 10% of the mix.
3.0m wide Screen Planting	Where space is limited planting at 1.0m centres for visual screening shall be of a minimum of 3m in width. The planting shall extend for a minimum of 100m to either side of any adjoining residential property or amenity. (refer to **Figures 12.4.01** to **12.4.14**)	Planting will include a dense planting at 1m centres of alder, birch, blackthorn, elder, geulder rose, holly, hawthorn, hazel, rowan, and willow species. Shrubs shall be planted at between 60 to 90cm in height. Scots pine of minimum 60cm in height at planting shall comprise 20% of the overall plant numbers and holly at a minimum of 45cm in height shall comprise a further 15%.

Reference	Location	Description of Measures
		Tree species, planted equally at half-standard (6-8cm girth) and standard size (8-10cm girth), shall comprise minimum 20% of the mix.
Stone Wall Boundaries	Stone walls as indicated on **Figures 12.4.01** to **12.4.15**)	Where indicated stone walls will be replaced along impacted sections of property and road boundaries on local roads. The stone from the disturbed sections of existing walls will be retained and re-used (generally granite to west; limestone to east) where possible to reinstate these new boundaries. The boundary walls may be backed by hedgerows of locally appropriate species, i.e. blackthorn, hawthorn and holly to west and hazel, hawthorn and holly to east. Elsewhere, where stone walls are removed the stone will be retained and made available for re-use by the adjacent property owners for the construction of a new stone wall on their side of the proposed development boundary if they wish.
Boundary Hedgerow	Typical double staggered hedgerow with tree planting, where locally appropriate	Primarily blackthorn (30%), hawthorn (40%) and holly (10%) hedgerow in west interspersed with other species (20%) such as elder, willow, and those found locally. Primarily hazel (30%), hawthorn (40%) and holly (10%) hedgerow to east interspersed with other species (20%) such as blackthorn elder, willow, and those found locally. Hawthorn plants shall be of c.90cm in height and planted at 50cm centres in each of two double staggered rows, 25cm apart. Other plants of c.50cm in height shall be interspersed. The hedgerow may be interspersed with 'half-standard-sized' (6-8cm girth) alder, birch and/or oak trees planted at random spacings but averaging a min. of 1 tree per 25 linear metre. Limited tree species, such as birch and mountain ash may also be included as 'whips' at 150cm in height.
Retaining Walls and structure over the N59 Moycullen Road	Use of reinforced earth retaining systems and limestone finishes for structural elements. Retaining Wall Structures R08/01; R08/02; R08/07 & R08/04; and Bridge Structure S08/02 (Ch. 8+300 to Ch. 8+670)	Where feasible reinforced earth retaining wall approaches will be incorporated so as allow for a green landscape finish to all or part of the retaining structures. Planting of trees shall also be provided along the base of the structure. These shall include smaller growing species such as alder, birch and rowan planted as Selected Standards (i.e. 14cm girth or greater) A limestone finish will be used for the external finish of the abutments for the proposed bridge over the N59 Moycullen Road and where structural walls are required. The stone will consist of natural limestone, matching the character of

Reference	Location	Description of Measures
		local stone, with a strong horizontal axis of between 5 to 1 and 7 to 1 (i.e. horizontal to vertical dimension).
Bat habitat enhancement	New 2m wide tree and shrub hedgerow, with occasional planted copses located north and east of Menlo Castle.	New hedgerow of native species will be established with plants at 0.5m staggered centres in each of 5 rows located 0.5m apart to sub-divide existing open fields. Standard-sized trees species (min 8-10cm girth, 2.4m high) will be planted at 15m staggered centres in each of the 3 central rows. Diverse range of shrub species will be planted between trees in the central rows and throughout the outer 2 rows. Circa 15m diameter woodland copses will be established within open fields using similar approach, densities and species. Planting will be protected by stock-proof fence, c.1.25m high located at 1.0m offset to either side of the outer row of the new hedgerow. Tree species to include alder, birch, oak, rowan, planted as standards (as above) and whips (1.25m high). Shrubs to comprise mainly blackthorn, hawthorn and hazel (combined 60%), with elder, holly, spindle, willow etc. Hawthorn plants shall be of between c.90cm in height and all other shrubs shall be c.60cm in height.
Wildlife Overpass	Ballindooley / Castlegar Structure S12/02 (Ch. 12+700)	Wildlife overpass (c.30m wide) will be landscaped to provide for connective habitat across proposed road development. Planting to consist of a central narrow grass path bounded on either side by tree-lined hedgerows of native species. Soil depths to vary from minimum c.45cm depth at edges to c.1.5m depth along centre-line of both hedgerows. Planted element of both hedgerow lines will be c.2m wide with standard-sized trees (min 8-10cm girth, 2.4m high) planted at 3m staggered centres in each of 2 rows in each hedgerow. Diverse range of shrub species will be planted between trees and along the line of each hedgerow. Planting to tie-in to proposed planting leading east and west on upper slopes of cuttings on both sides of the proposed road development. This will form a continuous hedgerow/planted network.

Reference	Location	Description of Measures
		Tree species to include alder, birch, oak, rowan, planted as standards (as above) and whips (1.25m high). Shrubs to comprise mainly blackthorn, hawthorn and hazel (combined 60%), with elder, holly, spindle, willow etc. Hawthorn plants shall be of between c.90cm in height and all other shrubs shall be c.60cm in height.
Barn Owl Tree Planting	Typical double staggered treeline with dense underplanting, between Ch. 9+600 and Ch. 10+100.	Deterrent tree planting to comprise alder, birch and/or rowan planted at 3m in height (min 12-14cm girth) and at 2.0m centres in each of 2 rows 1.5m apart. Dense low scrub planting to comprise blackthorn (50%), hawthorn (20%), hazel (10%) and holly (10%) interspersed with other species (10%) such as elder, willow, and those found locally. Hawthorn plants shall be of c.90cm in height and planted at 50cm centres. Blackthorn and other plants shall be of c.50cm in height and planted at 50cm centres in staggered rows, 50cm apart.
Barn Owl Scrub Planting	Dense low scrub planting on all embankments and cut slopes (other than rock cuttings or cut slopes left to naturally regenerate) from Ch. 8+550 to Ch.17+540.	Dense low scrub planting to comprise blackthorn (50%), hawthorn (20%) hazel (10%) and holly (10%) interspersed with other species (10%) such as elder, willow, and those found locally. Hawthorn plants shall be of c.90cm in height and planted at 50cm centres. Blackthorn and other plants shall be of c.50cm in height and planted at 50cm centres in staggered rows, 50cm apart.
Compensatory Habitat Areas (CHA)	Along Proposed Road Development Refer to 'CHA' locations on **Figures 12.4.01** to **12.4.14**)	Areas identified for compensatory habitat for mitigation of potential ecological impacts. Refer to **Chapter 8, Biodiversity** for further detail.

*** Note**: Due to the risk of Ash Dieback (*Chalara fraxinea*) and until further notice, ash (*Fraxinus* species) is no longer approved by the TII for planting schemes. This does not impact on the use of Mountain ash – also known as rowan (*Sorbus aucuparia*).

12.7 Residual Impacts

12.7.1 Introduction

Residual Impacts are outlined separately in the following sections under Construction Phase and Operational Phase.

12.7.2 Construction Phase

In landscape and visual terms, proposed mitigation measures will have limited effect during the construction stage, and relate more to the orderly development, protection of landscape on and external to the landtake and to minimisation of visual disruption and impact, where possible. For this reason, it is considered that the potential negative landscape and visual impacts as outlined in **Section 12.5.3** of this chapter will continue to arise, even with mitigation, during the temporary and short-term construction phase of the proposed road development.

12.7.3 Operational Phase

During the initial operation stage landscape and visual impacts will continue to arise from the physical presence and operation of the proposed road development. The proposed road development will be a significant and prominent new element in the landscape – at least until such stage as landscape mitigation proposals establish and become increasingly effective. As such, initial operational-stage landscape and visual impacts will continue to be pronounced and negative in the short-term (*i.e.* pre-establishment stage). With the development of mitigation planting, the significance and severity of landscape and visual impacts will gradually abate over time.

Negative visual impact will also continue to arise for residential and other properties located close to or adjoining the boundary of the proposed road development for some time (*i.e.* post-establishment stage).

Therefore, significant or notable residual landscape impacts will continue to arise:

- Along the edge of Sruthán Na Libeirtí, Bearna
- On the open elevated landscapes of Ballagh, Rahoon, Letteragh, Barnacranny and Dangan Upper
- On the recreation sports and amenity landscape of NUIG Sports Campus
- On the lowland landscape valley of the River Corrib, and the setting of Menlo Castle
- On the limestone landscape of Menlough and Coolough
- On the rolling landscape through Castlegar, south of Ballindooley Lough

Locations of these significant landscape impacts are provided on **Figures 12.4.01** to **12.4.14**.

Significant or notable residual visual impacts will continue to arise for properties:

- At the crossing of local roads north and northeast of Bearna (Foraí Maola Road, Troscaigh Road, Ann Gibbons Road, Aille Road)
- At the crossing of local roads northwest of Galway (Cappagh Road, Ballymoneen Road, Rahoon Road and Letteragh Road)
- To either side of the crossing of the N59 Moycullen Road north of Galway (The Heath, Barnacranny, Ard na Locha, Aughnacurra and at Bushypark/Ballagh)
- On the recreation sports and amenity landscape of NUIG Sports Campus
- On the lowland landscape valley of the River Corrib, and setting of Menlo Castle
- At the crossing of Bóthar Nua and Seanbóthar north/northeast of Galway City
- At the crossing of the N84 Headford Road, at Castlegar, (including crossing of School Road) and at the N83 Tuam Road, northeast of Galway
- At Ballybrit/Parkmore, at Racecourse Avenue, Ballybrit Crescent, Monivea Road and Coolagh-Briarhill east of Galway

Details of the visual impacts are provided in **Table 12.6** above, in **Appendix A.12.1** and are indicated on **Figures 12.4.01** to **12.4.14**.

12.7.4 Cumulative Impacts

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant landscape and/or visual effects. The assessment has considered statutory city and county plans and associated planning registers; local area plans, including those for Bearna, Gaeltacht, and Ardaun and the Údarás na Gaeltachta' Strategic Plan.

The construction and operational stages of the proposed road development give rise to rise to significant, very significant and profound landscape and visual impacts. These impacts are generally focused within the immediate corridor of the proposed road development on the urban/rural edge of the city. To the west and north of the city much of the lands along the corridor are identified for agricultural and/or amenity uses. Further sports and amenity developments are likely within the grounds of NUIG Sports Campus on the west bank of the river. While there are some small areas of residential zoning at Ballymoneen, Rahoon, Letteragh, Ballindooley and Castlegar, development in these areas is unlikely to give rise to significant landscape and visual impacts or cumulative impacts. An area of enterprise, industrial and related zoning is indicated to the north and east of Galway Racecourse, but much of these lands are already developed within Parkmore Business Park.

The eastern end of the proposed road development falls within the area covered by the Arduan Local Area Plan (LAP). The LAP proposes major development in the area, including new residential and commercial developments on c.81 hectares of an overall LAP area of c.164 hectares on the east side of the city. The existing M6/N6 corridor runs through the centre of the LAP area and the proposed road development ties-in to the existing road infrastructure within the LAP area. While the LAP envisages significant changes to the landscape and visual setting of the area, it is likely that the measures proposed will be delivered on a phased basis over a long period of time. Nevertheless, depending on timing of delivery, scope exists for some limited or not significant cumulative landscape and visual impacts to arise.

The Galway Transport Strategy (GTS) also envisages further transport-related developments, including public transport and cycleway and greenway measures. However, these measures are unlikely to further adversely impact the landscape or visual setting along the proposed road development.

The Galway Harbour Port Extension project is at planning stage. However, if permitted, it is not expected that any significant cumulative landscape or visual effects will arise because of the separation distance between the proposed road development and the port location.

Other projects, such as the M17 Galway to Tuam Road Project (operational); the N18 Oranmore to Gort Road Project (operational); the N83 Tuam Bypass (operational); the M6 Motorway (operational); the M6 Motorway Service Area (pre-planning); the N59 Maam Cross to Oughterard Road Project (consented and pre-construction); and the N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction), are considered too distant from the proposed road development to give rise to cumulative landscape and/or visual effects.

In summary it is considered that there is limited potential for any significant cumulative impacts with other planned or potential developments and that these will not further increase the adverse or negative impacts associated with the proposed road development.

12.8 Summary

The proposed road development passes through a generally rural landscape on the western, northern and eastern edge of Galway City. Residential development is a prominent feature, especially along local roads from Bearna through to Letteragh; in suburban developments at Barnacranny and Dangan on north of the city; along the N84 Headford Road at Ballindooley and around the village settlement of Castlegar to the east/northeast of the city.

Some areas along the proposed road development are of very high landscape and visual quality and sensitivity - especially centred on the River Corrib and its broad lowland valley, with the riverside ruin of Menlo Castle and the high quality amenity and sports grounds of NUIG. The remote and semi-natural limestone and scrub covered landscapes of Menlough and Coolough are also of significant landscape quality and sensitivity, while Ballindooley Lough and Galway Racecourse are also of notable landscape quality.

Due to the nature of the baseline landscape, the construction and initial operational stage of the proposed road development will give rise to a range of significant, very significant and profound landscape and visual impacts, at least until such stage as the extensive landscape mitigation proposals establish and become effective. With the development of mitigation planting, the significance and severity of landscape and visual impacts will gradually abate.

Even with the development of mitigation planting, negative visual impact will continue to arise for residential and other properties located close to or adjoining the boundary of the proposed road development and where the proposed road development, including the major River Corrib Bridge, crosses sensitive landscape areas.

Therefore, the proposed road development will continue to have longer-term visual impacts for properties located immediately along the proposed road development where it is on high embankments and requires retaining walls. This is of particular note through Barnacranny/Dangan and at Castlegar as well as at dispersed locations along the proposed road development.

The proposed bridge and associated embankments and viaduct on the east bank of the river will have a permanent and significant impact on the semi-natural landscape valley and setting of the River Corrib as well as on the recreational and sports amenity of the northern end of NUIG Sports Campus.

12.9 References

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Electronic Sources

www.osi.ie – Ordnance Survey Ireland

www.buildingsofireland.ie – National Inventory of Architectural Heritage (NIAH) Historic Gardens and Designed Landscapes

www.googleearth.com – Aerial photographic datasets

www.bingmaps.com – Aerial photographic datasets

www.galwaycity.ie – Galway City Council

www.galway.ie – Galway County Council

www.tiipublications.ie – TII (NRA) Publications

13 Archaeological, Architectural and Cultural Heritage

13.1 Introduction

This chapter of the EIAR consists of an appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, under the heading of archaeological, architectural and cultural heritage.

This chapter initially sets out the methodology followed in carrying out the appraisal (**Section 13.2**), describes the receiving environment (**Section 13.3**), and summarises the main characteristics of the proposed road development which are of relevance to the archaeological, architectural and cultural heritage (**Section 13.4**). The evaluation of impacts of the proposed road development on archaeological, architectural and cultural heritage are described (**Section 13.5**), measures are proposed to mitigate these impacts (**Section 13.6**), and residual impacts are described (**Section 13.7**). The chapter concludes with a summary (**Section 13.8**) and reference section (**Section 13.9**).

This chapter has utilised the information gathered during the constraints and route selections studies for proposed road development to inform the archaeological, architectural and cultural heritage impact appraisal. **Sections 4.11, 6.5.6** and **7.6.6** of the **Route Selection Report** examined the archaeological, architectural and cultural heritage constraints within the scheme study area and compared the potential of archaeological, architectural and cultural heritage impacts of the respective route options. These sections of the Route Selection Report contributed to the design of the proposed road development which this chapter appraises. It has also involved further detailed analysis of the archaeological, architectural and cultural heritage resources, including a full field inspection which is further discussed below.

13.2 Methodology

13.2.1 Introduction

This study determines, as far as reasonably possible from existing records, the nature of the cultural heritage resource within the footprint of the proposed road development and in the vicinity of the proposed road development using appropriate methods of study. Desk-based assessment is defined as a programme of study of the historic environment within a specified area or site that addresses agreed research and/or conservation objectives. It consists of an analysis of existing written, graphic, photographic and electronic information in order to identify the likely heritage assets, their interests and significance and the character of the study area, including appropriate consideration of the settings of heritage assets (IFA[1] 2012). This leads to the following:

- Determining the presence of known archaeological and built heritage sites that may be affected by the proposed road development
- Assessment of the likelihood of finding previously unrecorded archaeological remains during the construction programme
- Determining the impact upon the setting of known cultural heritage sites in the surrounding area (receiving environment)
- Suggested mitigation measures based upon the results of the above research

Research for the EIAR has been undertaken in two phases. The first phase comprised a paper survey of all available archaeological, architectural, historical and cartographic sources. The second phase involved a field inspection of the proposed road development.

The study involved detailed interrogation of the archaeological, historical and architectural nature of the receiving environment of the proposed road development. This included information from the Record of Monuments and Places of County Galway, the County and City Development Plans, the topographical files of the National Museum of Ireland and cartographic and documentary records. Aerial photographs of the study area were also consulted. Field inspections were carried out along the route of the proposed road development in December 2015 and July 2016 in an attempt to identify any known cultural heritage sites and previously unrecorded features, structures and portable finds within the footprint of the proposed road development.

The receiving environment is defined as an area measuring c. 250m from the edge (proposed development boundary) of the proposed road development [2] Measurements are taken from the proposed development boundary to the upstanding remains of a site or structure. Where there are no upstanding remains, the measurement is taken to the centre of the site as indicated within **Figures 13.1** to **13.14**.

13.2.2 Legislation and Guidelines

The study has been carried out in accordance with the Code of Practice that was agreed between the Transport Infrastructure Ireland (TII) and the Minister for Arts, Heritage, Gaeltacht and the Islands (now the Department of Culture, Heritage and the Gaeltacht, DoCHG) and EPA Guidelines and advice notes (2003 & 2017).

The following legislation, standards and guidelines were also consulted as part of the assessment.

- National Monuments Act 1930 to 2014
- The Planning and Development Acts 2000 to 2017

[1] Institution of Field Archaeologists
[2] NRA guidelines (page 57) recommend a minimum of 50m either side of the road centreline

- Heritage Act, 1995, as amended
- Guidelines on the information to be contained in Environmental Impact Statements, 2003, EPA
- Advice Notes on Current Practice (in preparation of Environmental Impact Statements), 2003, EPA
- Draft Advice Notes on Current Practice (in preparation of Environmental Impact Statements), 2015, EPA
- Guidelines on the information to be contained in Environmental Impact Statements, Draft 2015, EPA
- Guidelines on the information to be contained in environmental impact assessment reports (Draft August 2017), EPA
- Frameworks and Principles for the Protection of the Archaeological Heritage, 1999, (formerly) Department of Arts, Heritage, Gaeltacht and Islands
- Architectural Heritage (National Inventory) and Historic Monuments (Miscellaneous Provisions) Act, 2000 and the Local Government (Planning and Development) Act 2000
- Code of Practice for Archaeology agreed between the Minister for Arts, Heritage, Regional, Rural and Gaeltacht Affairs (now the Department of Culture, Heritage and the Gaeltacht) and Transport Infrastructure Ireland, July 2017
- Guidelines for the Assessment of Archaeological & Architectural Heritage Impacts of National Road Schemes, 2005, NRA

13.2.3 Data Sources and Consultations

13.2.3.1 Consultations

Following the initial research, a number of statutory and voluntary bodies were consulted to gain further insight into the cultural background of the receiving environment and study area, as follows:

- Department of Culture, Heritage and the Gaeltacht – the Heritage Service, National Monuments and Historic Properties Section: Record of Monuments and Places; Sites and Monuments Record; Monuments in State Care Database; Preservation Orders; Register of Historic Monuments
- National Museum of Ireland, Irish Antiquities Division: topographical files of Ireland
- National Inventory of Architectural Heritage: County Galway
- Galway City and County Council: Planning Section
- Study Area and Baseline Data Collection

13.2.3.2 Paper Survey

This is a document search. The following sources were examined and a list of areas of archaeological, architectural and cultural heritage potential was compiled:

- Record of Monuments and Places for County Galway
- Sites and Monuments Record for County Galway
- Monuments in State Care Database
- Preservation Orders
- Register of Historic Monuments
- Topographical files of the National Museum of Ireland
- Cartographic and written sources relating to the study area
- Galway County Development Plan 2015 – 2021
- Galway City Development Plan 2011 – 2017 & 2017 – 2023
- Bearna Local Area Plan 2007 – 2017
- National Inventory of Architectural Heritage County Galway (Architectural & Garden Survey)
- Aerial photographs
- Excavations Bulletin (1970 – 2016)
- Place name analysis

Record of Monuments and Places (RMP) Section 12 (1) of the National Monuments Act (1994 amendment) provides that the Minister for Arts, Heritage, Gaeltacht and the Islands (now the Minister for Culture, Heritage and the Gaeltacht) shall establish and maintain a record of monuments and places (RMP) where it is known that such monuments exist. The record comprises of a list of monuments and relevant places and mapping showing each monument and relevant place in respect of each county in the State. Sites recorded on the Record of Monuments and Places all receive statutory protection under the National Monuments Act. All recorded monuments are referred to as Archaeological Heritage (AH sites) within this appraisal.

Sites and Monuments Record (SMR) holds documentary evidence and records of field inspections of all known archaeological sites and monuments. Some information is also held about archaeological sites and monuments whose precise location is not known e.g. only a site type and townland are recorded. These are known to the National Monuments Section as ‘un-located sites’ and cannot be afforded legal protection. As a result, these are omitted from the Record of Monuments and Places. SMR sites are also listed on a website maintained by the DoCHG – www.archaeology.ie. All Recorded Monuments are referred to as Archaeological Heritage (AH sites) within this assessment.

It should be noted that revisions are proposed to the RMP and SMR, with some sites listed as redundant records and proposed for removal and other, newly discovered sites, proposed for inclusion. Some of the recorded sites within the receiving environment of the proposed road development fall into this category. As the revisions have yet to take place, all current RMP/SMR sites are listed as AH sites within this assessment, with the relevant detail provided as to the nature and extent of each site included.

National Monuments in the State Care Database is a list of all the National Monuments in the State guardianship or ownership. Each is assigned a National Monument number whether in guardianship or ownership and has a brief description of each monument.

A National Monument receives statutory protection and is described as 'a monument or the remains of a monument the preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic or archaeological interest attaching thereto' (National Monuments Act, 1930, Section 2).

The Minister for the Department of Environment, Heritage and Local Government (now the Minister for Culture, Heritage and the Gaeltacht) may acquire National Monuments by agreement or by compulsory order. The State or Local Authority may assume guardianship of any National Monument (other than dwellings). The owners of National Monuments (other than dwellings) may also appoint the Minister or the Local Authority as guardian of that monument if the State or Local Authority agrees. Once the site is in ownership or guardianship of the State, it may not be interfered with without the written consent of the Minister. There are no National Monuments located within the footprint of the proposed road development and its receiving environment.

Preservation Orders List and/or Temporary Preservation Orders, can be assigned to a site or sites that are deemed to be in danger of injury or destruction. Orders are allocated under the National Monuments Act, 1930. Preservation Orders make any interference with the site illegal. Temporary Preservation Orders can be attached under the National Monuments Act, 1954. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders with the written consent, and at the discretion, of the Minister (DoCHG). There are four sites that possess Preservation Orders within the receiving environment of the proposed road development under assessment. These are referred to as Archaeological Heritage (AH sites) within this assessment.

Register of Historic Monuments was established under Section 5 of the 1987 amendment to the 1930 National Monuments Act and requires the Minister to establish and maintain such a record. Historic monuments and archaeological areas included in the register are afforded statutory protection under the National Monuments Act 1987 amendment. The register also includes sites under Preservation Orders and Temporary Preservation Orders. All registered monuments are included in the Record of Monuments and Places.

Topographical files of the National Museum of Ireland is the national archive of all known finds recorded by the National Museum. This archive relates primarily to artefacts but also includes references to monuments and unique records of previous excavations. The find spots of artefacts are important sources of information on the discovery of sites of archaeological significance.

Cartographic sources are important in tracing land use development within the proposed road development area and its receiving environment as well as providing important topographical information on areas of archaeological potential and the construction of buildings. Cartographic analysis of all relevant maps has been made to identify any topographical anomalies or structures that no longer remain within the landscape. These included current and former townland and parish boundaries.

All sites of potential archaeological or architectural heritage merit identified during the map analysis are listed as Cultural Heritage (CH) sites within this assessment. All Townland Boundaries are listed as TB 1, 2 etc. In addition, all Areas of Archaeological Potential (AAPs) identified during the analysis of mapping (and other sources including field inspection) are referred to as AAPs within this assessment.

The cartographic sources consulted include:

- Down Survey Barony Map of Galway (1654 – 1656)
- Ordnance Survey 6” and 25” maps of Co. Galway (1841, 1895 – 1900, 1928 – 1929)

Documentary sources were consulted to compile background information on the archaeological, architectural and cultural heritage receiving environment of the proposed road development area.

Development Plans contain a catalogue of all the Protected Structures, archaeological sites and Architectural Conservation Areas within every county. The development plans for County Galway (2015 – 2021), Galway City (2011 – 2017 / 2017 – 2023) and the Bearna Local Area Plan (2007 – 2017) were examined as part of this assessment. All protected structures are referred to as Built Heritage sites (BH) as part of this assessment. There are no Architectural Conservation Areas located within the receiving environment of the proposed road development.

The National Inventory of Architectural Heritage (NIAH) is a government based organisation tasked with making a nationwide record of locally, regionally, nationally and internationally significant structures, which in turn provides county councils with a guide as to what structures to list within the Record of Protected Structures. The NIAH have also carried out a nationwide desk based survey of historic gardens, including demesnes that surround large houses. All NIAH structures are referred to as Built Heritage sites (BH) as part of this appraisal.

Whilst the NIAH Garden Survey was utilised as part of this assessment, this was carried out in conjunction with detailed analysis of the first edition OS maps and field inspection, in order to identify all designed landscapes (DL) within receiving environment of the proposed road development.

Aerial photographic coverage is an important source of information regarding the precise location of sites and their extent. It also provides information on the terrain and its likely potential for archaeology. Ordnance Survey aerial photographs (1995, 2000, 2005), Google Earth coverage (2003 – 2012) and Bing Maps were examined for this assessment. All sites identified during cartographic or aerial photographic assessment are identified as Cultural Heritage (CH) sites within this assessment. All

Areas of Archaeological Potential identified during the analysis are referred to as AAPs within this assessment.

Excavations Bulletin is a summary publication that has been produced every year since 1970. This summarises every archaeological excavation that has taken place in Ireland during that year up until 2010 and since 1987 has been edited by Isabel Bennett. This information is also available online (www.excavations.ie) from 1970 – 2016. Information from this resource is vital when examining the archaeological content of any area, which may not have been recorded under the SMR and RMP files.

Place Names are an important part in understanding both the archaeology, history and cultural heritage of an area. Place names can be used for generations and in some cases have been found to have their root deep in the historical past. The main references used for the place name analysis is *Irish Local Names Explained* by P.W Joyce (1870) and the Place Names Database of Ireland.

13.2.3.3 Field Inspection

Field inspection is necessary to determine the extent and nature of archaeological and architectural remains and can also lead to the identification of previously unrecorded or suspected sites and portable finds through topographical observation and local information.

The archaeological and architectural field inspection was carried out from the 30 of November to the 04 of December 2015 and during sunny conditions on the 26 of July 2016 and entailed:

- Noting and recording the terrain type and land usage
- Noting and recording the presence of known and previously unknown features of archaeological, architectural or cultural heritage significance
- Verifying the extent and condition of recorded sites and structures (RMPs/ RPS/ NIAH)
- Visually investigating any suspect landscape anomalies to determine the possibility of their being anthropogenic in origin and of archaeological, architectural or cultural heritage significance

13.2.3.4 Geophysical Survey

Geophysical survey is used to create ‘maps’ of subsurface archaeological features. Features are the non-portable part of the archaeological record, whether standing structures or traces of human activities left in the soil. Geophysical instruments can detect buried features when their electrical or magnetic properties contrast measurably with their surroundings. In some cases, individual artefacts especially metal, may be detected as well. Readings taken in a systematic pattern become a dataset that can be rendered as image maps. Survey results can be used to guide excavation and to give archaeologists insight into the patterning of non-excavated parts of the site. Unlike other archaeological methods, geophysical survey is not invasive or destructive.

As part of the assessment, a survey was carried out within one area of archaeological potential identified during the baseline assessment and field inspection. This area is located within the townland of Bushypark and the survey area including an area adjacent to a church and graveyard (BH 7) and a previously unknown platform in the landscape that may possess archaeological potential (CH 38).

The geophysical survey was carried out by Earthsound Archaeological Geophysics on behalf of IAC Ltd for Galway County Council and TII. It took place on the 17 and 18 of November 2016 under licence 16R0190.

13.2.4 Impact Evaluation Methodology

The quality and type of a potential impacts can vary to include the following (as per TII's Guidelines for the Assessment of Archaeological/Architectural Heritage Impacts of National Road Schemes (NRA, 2005, 25/54):

Negative Impact: A change that will detract from or permanently remove an archaeological/architectural monument/structure from the landscape.

Neutral Impact: A change that does not affect the archaeological/architectural heritage.

Positive Impact: A change that improves or enhances the setting of an archaeological/architectural monument/structure.

Direct Impact: Where an archaeological/architectural feature or site is physically located within the footprint of a potential route and entails the removal of part, or all of the monument or feature.

Indirect Impact: Where a feature or site of archaeological/architectural heritage merit or its setting is located in close proximity to the footprint of a potential route alignment.

No Predicted Impact: Where the potential route does not adversely or positively affect an archaeological/architectural heritage site.

It should be noted that whilst impact levels and definitions are applied consistently to the cultural heritage resource, direct impacts on sites that are subject to statutory protection are considered to be more significant than sites/structures not subject to statutory protection.

Impact Definitions (as outlined in the TII's Guidelines for the Assessment of Archaeological/Architectural Heritage Impacts of National Road Schemes (NRA, 2005, 54/21), are included in **Table 13.1** and **13.2** below. These have been supplemented with the additional impact definitions as per the most recent EPA guidelines (2017).

Table 13.1: Impact Definitions: Archaeology

Type of Impact	Definitions relating to sites of an archaeological nature
Profound	Applies where mitigation would be unlikely to remove adverse effects. Reserved for adverse, negative effects only. These effects arise when an archaeological site is completely and irreversibly destroyed by a proposed development
Very Significant	Effects which, by its character, magnitude, duration or intensity significantly alters the majority of a sensitive aspect of the environment
Significant	An impact which, by its magnitude, duration or intensity, alters an important aspect of the environment. An impact like this would be where part of a site would be permanently impacted upon, leading to a loss of character, integrity and data about the archaeological feature/site
Moderate	A moderate impact arises where a change to the site is proposed, which although noticeable, is not such that the archaeological integrity of the site is compromised and which is reversible. This arises where an archaeological feature can be incorporated into modern day development without damage and that all procedures used to facilitate this are reversible
Slight	An impact which causes changes to the character of the environment which are not significant or profound and do not directly impact or affect an archaeological feature or monument
Not significant	Effects which causes noticeable changes in the character of the environment but without noticeable consequences
Imperceptible	An impact capable of measurement but without noticeable consequences

Table 13.2: Impact Definitions: Architecture

Type of Impact	Definitions relating to sites of an architectural nature
Profound	An impact that obliterates the architectural heritage of a structure or feature of national or international importance. These effects arise where an architectural structure or feature is completely and irreversibly destroyed by the proposed development. Mitigation is unlikely to remove adverse effects
Very Significant	Effects which, by its character, magnitude, duration or intensity significantly alters the majority of a sensitive aspect of the environment
Significant	An impact that, by its, magnitude, duration or intensity alters the character and/or setting of the architectural heritage. These effects arise where an aspect or aspects of the architectural heritage is/are permanently impacted upon leading to a loss of character and integrity in the architectural structure or feature. Appropriate mitigation is likely to reduce the impact
Moderate	An impact that results in a change to the architectural heritage which, although noticeable, is not such that alters the integrity of the heritage. The change is likely to be consistent with existing and emerging trends. Impacts are probably reversible and may be of relatively short duration. Appropriate mitigation is very likely to reduce the impact
Slight	An impact that causes some minor change in the character of architectural heritage of local or regional importance without affecting its integrity or sensitivities. Although noticeable, the effects do not directly impact on the architectural structure or feature. Impacts are reversible and of relatively short duration. Appropriate mitigation will reduce the impact
Not significant	Effects which causes noticeable changes in the character of the environment but without noticeable consequences
Imperceptible	An impact on architectural heritage of local importance that is capable of measurement but without noticeable consequences

13.3 Receiving Environment

13.3.1 Results and Analysis

13.3.1.1 General

The proposed road development traverses the baronies, parishes and townlands listed in **Table 13.3** below. A detailed archaeological and historical background is provided in **Appendix A.13.1**.

Table 13.3: Baronies, Parishes and Townlands

Barony	Parish	Townland
Galway	Rahoon	Na hAille, Ballynahown East, Bushypark, An Cheapach, An Chloch Scoilte, Na Foraí Maola Thoir, Na Foraí Maola Thiar, Kentfield, Mincloon, An Baile Nua, Rahoon, Troscaigh Thoir, Troscaigh Thiar, Ballard West, Ballard East, Keeraun, Letteragh, Ballagh, Barnacranny, Dangan Upper, Dangan Lower
	St. Nicholas	An Caisleán Gearr, Cappanabornia, Parkmore, Ballybrit
Galway	Oranmore	Ballindooley, Mionlach, Pollkeen, Doughiska
Dunkellin		Breanloughaun, Coolagh

13.3.1.2 Recorded Monuments (AH sites) within the Receiving Environment

A total of 41 Archaeological Heritage sites (AH) are recorded within the receiving environment of the proposed road development (**Table 13.4**). However, the existing Sites and Monuments Record (SMR) and Record of Monuments and Places (RMP) is currently under review and a number of changes relating to some sites have been proposed in the record by the Department of Culture, Heritage and the Gaeltacht (www.archaeology.ie). As such, five redundant records are included within the 41 sites, which will be removed from the SMR. These sites have been classed by the DoCHG as being non-archaeological.

A further eight sites are proposed for removal due to their relatively recent date (AH 9, 10, 12, 17, 20, 27, 38, 39). Two sites will be removed from the Record as they are no longer extant having already been removed from the landscape due to quarrying (AH 18, 19). Two further sites will be removed from the record as they have been removed by modern development (AH 30, 31). One of the sites represents a series of probable prehistoric burnt mounds that have been excavated (AH 36). The entry is not proposed for removal from the record.

Four of the recorded sites within the townland of Ballybrit are further protected with Preservation Orders and as such are deemed to be of national importance (AH 32 - 35).

Of the 41 sites, nine are also classed as Protected Structures within the Galway City Development Plan (2017 – 2023). As such, these sites are also subject to statutory protection under the Planning and Development Act, 2000, as amended (AH 4, 15, 16, 22, 23, 25, 29, 33, 41).

The detail relating to each AH site is included in **Appendix A.13.2** of this EIAR and marked on **Figures 13.1.1** to **13.1.14**.

Table 13.4: Archaeological Heritage (AH) sites located within the receiving environment

AH No.	RMP No.:	Townland:	Classification:	Approx. Ch.	Dist. from proposed road development	Statutory protection
AH 1[3]	GA093-009	Na Foraí Maola Thiar	Redundant record: non-antiquity	0+500	9m east	None
AH 2	GA082-077	Rahoon	Bullaun Stone	6+850	0m	RMP
AH 3[4]	GA082-040	Dangan Lower	Redundant record: non-antiquity	8+350	57m southeast	None
AH 4[5]	GA094-047	Rahoon	House (Rahoon House) Also BH 18)	N59 Link Road South 3+350	153m southeast	RMP
AH 5	GA094-056	Rahoon	Designed Landscape Feature	Gort na Bró Road	61m southwest	RMP
AH 6	GA082-104	Bushypark	Enclosure	9+100	195m northwest	RMP
AH 7[6]	GA082-032	Dangan Lower	Redundant record: non-antiquity	8+750	86m northeast	None
AH 8	GA082-039	Dangan Lower	Children's Burial Ground	8+850	60m northeast	RMP
AH 9[7]	GA082-087	Mionlach	Settlement cluster	9+800	To the immediate north of the area proposed for habitat enhancement for bats. 573m northwest of proposed road development.	None

[3] Scheduled for removal from the RMP/SMR – 19/07/16
[4] Scheduled for removal from the RMP/SMR – 19/07/16
[5] Scheduled for removal from the RMP/SMR – 19/07/16
[6] Scheduled for removal from the RMP/SMR – 19/07/16
[7] Scheduled for removal from the RMP/SMR – 30/07/17

AH No.	RMP No.:	Townland:	Classification:	Approx. Ch.	Dist. from proposed road development	Statutory protection
AH 10[8]	GA082-041	Dangan Lower	Well	8+650	173m east-southeast	None
AH 11	GA082-033	Dangan Lower	Barrow	8+700	198m southeast	RMP
AH 12[9]	GA082-036	Dangan Lower	Site of House (Dangan House)	9+150	90m northwest	RMP
AH 13	GA082-085	Dangan Lower	Designed Landscape Feature	9+050	112m east-southeast	RMP
AH 14	GA082-038	Dangan Lower	Designed Landscape Feature	9+150	140m southeast	RMP
AH 15	GA082-037	Dangan Lower	Summer house (Also BH 9)	9+300	72m southeast	RMP
AH 16	GA082-064/001	Mionlach	House – 17th century, Castle, unclassified (Also BH 10)	9+375	Adjacent to the area proposed for habitat enhancement for bats. 140m northwest of proposed road development	RMP
AH 17[10]	GA082-100	Mionlach	Clearance cairn	9+500	Within the proposed for habitat enhancement for bats. 167m northwest of proposed road development	None
AH 18[11]	GA082-031	Coolagh	Enclosure	11+350	0m	None
AH 19[12]	GA082-095	Coolagh	Ringfort	11+400	0m	None
AH 20[13]	GA082-003	Ballindooley	Quarry	12+025	81m north	RMP

[8] Scheduled for removal from the RMP/SMR – 19/07/16
[9] Scheduled for removal from the RMP/SMR – 19/07/16
(Note as of 21/06/17 no changes have occurred within the Record re schedules for exclusion and inclusion)
[10] Scheduled for removal from the RMP/SMR – 19/07/16
[11] Removed by quarrying - Scheduled for removal from the RMP/SMR – 19/07/16
[12] Removed by quarrying - Scheduled for removal from the RMP/SMR – 19/07/16
[13] Scheduled for removal from the RMP/SMR – 19/07/16

AH No.	RMP No.:	Townland:	Classification:	Approx. Ch.	Dist. from proposed road development	Statutory protection
AH 21[14]	GA082-004	Ballindooley	Redundant record: non-antiquity	12+200	131m east-northeast	None
AH 22	GA082-060	Mionlach	Pillar stone (Also BH 23)	9+850	68m north of proposed habitat enhancement for bats. 530m northwest of proposed road development.	RMP
AH 23	GA082-023	An Caisleán Gearr	Chapel (site of) (Also BH 14)	13+075	80m north	RMP
AH 24[15]	GA082-026	An Caisleán Gearr	Redundant record: non-antiquity	12+975	0m	None
AH 25	GA082-021	An Caisleán Gearr	Tower house (Also BH 13)	12+950	220m south	RMP
AH 26	GA082-022	An Caisleán Gearr	Children's burial ground	13+500	73m southwest	RMP
AH 27[16]	GA082-072	Parkmore	Quarry	14+000	0m	None
AH 28	GA082-016	Ballybrit	Anomalous stone group	14+850	124m southwest	RMP
AH 29	GA082-011/001-2	Ballybrit	Cashel, souterrain, children's burial ground (Also BH 17)	15+150	40m southwest	RMP
AH 30[17]	GA082-017	Ballybrit	Earthwork	City East Business Park Junction	0m	RMP
AH 31[18]	GA082-015	Ballybrit	Designed landscape feature	City East Business Park Junction	57m south	None
AH 32	GA082-012002	Ballybrit	Deserted medieval settlement	14+500	226m northeast of the City East Business Park Junction	RMP/ Preservation Order

[14] Scheduled for removal from the RMP/SMR – 19/07/16
[15] Scheduled for removal from the RMP/SMR – 19/07/16
[16] Scheduled for removal from the RMP/SMR – 19/07/16
[17] Removed by development - Scheduled for removal from the RMP/SMR – 19/07/16
[18] Removed by development - Scheduled for removal from the RMP/SMR – 19/07/16

AH No.	RMP No.:	Townland:	Classification:	Approx. Ch.	Dist. from proposed road development	Statutory protection
AH 33	GA082-012001	Ballybrit	Tower house (Also BH 16)	14+500	250m northeast of the City East Business Park Junction	RMP/ Preservation Order
AH 34	GA082-014	Ballybrit	Enclosure	15+050	110m northeast of the City East Business Park Junction	RMP/ Preservation Order
AH 35	GA082-013/001	Ballybrit	Ringfort & house (unknown date)	15+050	165m northeast of the City East Business Park Junction	RMP/ Preservation Order
AH 36[19]	GA082-043/001-4	Doughiska	Fulachta fia	16+400	0m	RMP
AH 37	GA082-044	Doughiska	Road	16+350	43m west southwest	RMP
AH 38[20]	GA082-063	Mionlach	Designed landscape feature	9+550	Adjacent to proposed habitat enhancement for bats. 448m northwest of proposed road development.	None
AH 39[21]	GA082-062	Mionlach	Designed landscape feature	9+650	Within proposed habitat enhancement for bats. 448m northwest of proposed road development	None
AH 40	GA082-061	Mionlach	Burial ground	9+600	Adjacent to proposed habitat enhancement for bats. 577m northwest of proposed road development.	RMP

[19] Fully excavated (Excavation Ref.: A024/1.1, E2052)

[20] Scheduled for removal from the RMP/SMR – 30/06/17

[21] Scheduled for removal from the RMP/SMR – 30/06/17

AH No.	RMP No.:	Townland:	Classification:	Approx. Ch.	Dist. from proposed road development	Statutory protection
AH 41	GA082-070	Mionlach	Gate house (Also BH 21)	9+750	50m east of proposed habitat enhancement for bats. 406m northwest of proposed road development.	RMP

Of the 41 AH sites that have been identified seven of the sites are recorded within the footprint of the proposed road development. However, two of the sites have already been removed by quarrying (AH 18, 19); one site has been removed by existing development (AH 31) and one area has already been subject to archaeological excavation (AH 36). AH 24 is listed as a non-antiquity and AH 27 is listed as a quarry and as such does not possess archaeological significance. AH 2 is listed as the site of a bullaun stone; however, no trace of the feature has been identified during the course of this assessment.

Two further sites are located within the proposed development boundary which is outside the footprint of the proposed road development but required for habitat planting in Mionlach. AH 39 is listed as a designed landscape feature and is not considered to possess archaeological significance as it is scheduled for removal from the SMR/RMP. Similarly, AH 17, which is listed as a clearance cairn within this proposed habitat planting area is also scheduled for removal. A further designed landscape feature is located immediately adjacent to the proposed habitat planting area (AH 38), along with a recorded burial ground, located to the immediate west of the proposed habitat planting area (AH 40). Menlo Castle (AH 16) is located c. 140m northwest of the proposed road development. However, the edge of the habitat planting area is located to the immediate east of the castle structure.

13.3.1.3 National Museum of Ireland (NMI): Topographical Files

Information from the NMI topographical files listed a stone ard fragment (1987:184) and an iron axehead (1983:61) recovered from the townland of Dangan Lower. A number of lithic artefacts are listed under the townland of Mionlach, including seven stone axeheads of ‘Shannon type’ (KK131129, 2005C1:802, 1638:W307, 1637:W306, 1636:W305, 1635:W304, 1634:W303[22]); a collection of twenty blades of various geologies (1280:W5) and a chert blade (2005C1:801). A ‘beehive’ type quern top and base (2011:252) have also been recovered from the townland of An Caisleán Gearr. Details relating to the finds are listed in **Appendix A.13.3**.

[22] Polished stone axeheads of Neolithic date

13.3.1.4 Protected Structures (BH sites) within the Receiving Environment

A review of the Galway City Development Plan and Galway County Development Plan, has shown that a total of 27 Protected Structures (BH sites) are recorded within the study area of the proposed road development (**Table 13.5**). Six of the structures are also listed within the National Inventory of Architectural Heritage (NIAH) (see **Section 13.3.1.6**).

Of the 27 structures, nine are also classed as Recorded Monuments (BH 9, 10, 13, 14, 16, 17, 18, 21, 23). As such, these sites are also subject to statutory protection under the National Monuments Act.

The detail relating to each BH site is included in **Appendix A.13.4** of this EIAR and marked on **Figures 13.1.01** to **13.1.14**.

Table 13.5: Built Heritage (BH) sites located within the receiving environment

BH No.:	RPS No.:	Townland:	Classification:	Approx. Ch.	Dist. from proposed road development	NIAH
BH 1	6302	Mincloon	Thatched cottage	6+150	53m northwest	No
BH 2	6301	Mincloon	Thatched cottage	6+400	183m southeast	No
BH 3[23]	2001	Barnacranny	Gate pillars	8+450	Adjacent	No
BH 4	2901	Barnacranny	Thatched cottage	8+450	6m southwest	Yes
BH 5	1504	Kentfield	Bushypark House	N59 Link Road North 0+000	60m northeast	Yes
BH 6	1503	Ballagh	Thatched Cottage	N59 Link Road North 0+050	124m northwest	No
BH 7	1501/ 02	Ballagh	Church	N59 Link Road North 0+060	20m southeast	Yes
BH 8[24]	3003	Ballagh	Remains of stone fort	8+950	184m east-northeast	No
BH 9	3001	Dangan Lower	Summer house (Also AH 15)	9+300	72m southeast	No
BH 10	5702	Mionlach	Menlo Castle (Also AH 16)	9+350	140m northwest of proposed road development	Yes
BH 11	2402	Coolagh	Thatched cottage	10+750	63m northwest of the proposed	No

[23] No evidence of gate pillars at this location
[24] No evidence of this site type at this location

BH No.:	RPS No.:	Townland:	Classification:	Approx. Ch.	Dist. from proposed road development	NIAH
					development at Lackagh Quarry	
BH 12	1703	An Caisleán Gearr	Thatched cottage	12+875	0m	Yes
BH 13	1701	An Caisleán Gearr	Tower House (Also AH 25)	12+950	220m south	No
BH 14	1702	An Caisleán Gearr	Chapel, site of (Also AH 23)	13+100	80m north	No
BH 15	7601	Parkmore	Two ruined cottages	13+800	99m southwest	No
BH 16	701	Ballybrit	Tower House (Also AH 33)	14+500	250m northeast of the City East Business Park Junction	No
BH 17	702	Ballybrit	Cashel (Also AH 29)	15+150	40m southwest	No
BH 18	8301	Rahoon	Rahoon House (Also AH 4)	N59 Link Road South 3+350	153m southeast	No
BH 19	8301	Rahoon	Entrance to Rahoon House	N59 Link Road South 3+300	188m southeast	Yes
BH 20	1705	An Caisleán Gearr	Free standing stone cross	13+450	162m southwest	No
BH 21	5703	Mionlach	Gate house (Also AH 41)	9+750	406m northwest of proposed road development. 50m east of area proposed for habitat planting	Yes
BH 22	5710	Mionlach	Thatched cottage	9+800	522m northwest of proposed road development. 53m north of area proposed for habitat planting	Yes
BH 23	5704	Mionlach	Pillar stone (Also AH 22)	9+850	530m northwest of proposed road development 68m north of area proposed for habitat planting	No
BH 24	5709	Mionlach	Thatched cottage	9+850	586m northwest of proposed road development.	Yes

BH No.:	RPS No.:	Townland:	Classification:	Approx. Ch.	Dist. from proposed road development	NIAH
					97m north of area proposed for habitat planting	
BH 25	5708	Mionlach	Thatched cottage	9+000	596m northwest of proposed road development. 163m north of area proposed for habitat planting	Yes
BH 26	5707	Mionlach	Thatched cottage	9+950	645m northwest of proposed road development. 191m north of area proposed for habitat planting	Yes
BH 27	5711	Mionlach	Thatched cottage	9+950	319m northwest of proposed road development. 200m northeast of area proposed for habitat planting	Yes

Of the 27 Protected Structures, one is located within the footprint of the proposed road development. This consists of a single storey thatched cottage within the townland of An Caisleán Gearr (BH 12). The structures identified at Mionlach (BH 21-27) are located within the receiving environment of the area proposed for habitat planting rather than the proposed road development.

13.3.1.5 National Inventory of Architectural Heritage structures (BH sites) within the Receiving Environment

A review of the National Inventory of Architectural Heritage (NIAH) has shown that there are 13 NIAH structures located within the receiving environment of the proposed road development (**Table 13.6**). All of these structures are listed as protected in the Galway City Development Plan. In addition, two of the buildings are also Recorded Monuments (Menlo Castle BH 10/AH 16 and Menlo Castle Gate house BH 21/AH 41).

Inclusion within the NIAH does not confer statutory protection. However, as the buildings are listed within the Record of Protected Structures, these buildings are subject to statutory protection under the Planning and Development Act (2000).

The detail relating to each BH site is included in **Appendix A.13.4** of this EIAR and marked on **Figures 13.1.01** to **13.1.14**.

Table 13.6: National Inventory of Architectural Heritage (BH) sites located within the receiving environment

BH No.	NIAH No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	RPS
BH 4	30408205	Barnacranny	Thatched cottage	8+450	6m southwest	Yes
BH 5	30408203	Bushypark	Bushypark House	N59 Link Road North 0+000	60m northeast	Yes
BH 7	30408204	Ballagh	Church	N59 Link Road North 0+060	20m southeast	Yes
BH 10	30408220	Mionlach	Menlo Castle (Also AH 16)	9+350	Adjacent to the area proposed for habitat planting. 140m northwest of proposed road development	Yes
BH 12	30408211	An Caisleán Gearr	Thatched cottage	12+875	0m	Yes
BH 19	30311001	Rahoon	Entrance to Rahoon House	N59 Link Road South 3+300	188m southeast	Yes
BH 20	30408212	An Caisleán Gearr	Free standing stone cross	13+450	162m southwest	Yes
BH 21	30408219	Mionlach	Gate house (Also AH 41)	9+750	406m northwest of proposed road development. 50m east of area proposed for habitat planting	Yes
BH 22	30408216	Mionlach	Thatched cottage	9+800	522m northwest of proposed road development. 53m north of area proposed for habitat planting	Yes
BH 24	30408215	Mionlach	Thatched cottage	9+850	586m northwest of proposed road development. 97m north of area proposed for habitat planting	Yes
BH 25	30408214	Mionlach	Thatched cottage	9+000	596m northwest of proposed road development	Yes

BH No.	NIAH No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	RPS
					163m north of area proposed for habitat planting	
BH 26	30408213	Mionlach	Thatched cottage	9+950	645m northwest of proposed road development. 191m north of area proposed for habitat planting	Yes
BH 27	30408217	Mionlach	Thatched cottage	9+950	319m northwest of proposed road development. 200m northeast of area proposed for habitat planting	Yes

13.3.1.6 Architectural Conservation Areas (ACAs) within the Receiving Environment

A review of the Galway City Development Plan and Galway County Development Plan, has shown that there are no ACAs located within the receiving environment of the proposed road development. The closest ACA, Bearna Village and environs, is located over 940m to the southeast of the proposed road development.

13.3.1.7 Designed Landscapes

A number of sources were reviewed in order to define the nature and extent of designed landscapes within the receiving environment of the proposed road development. These included the historic Ordnance Survey (OS) mapping, aerial photographic coverage, the NIAH Garden Survey, the Landed Estates Database and field inspections.

A total of nine designed landscapes have been identified within the receiving environment of the proposed road development (**Table 13.7**). Of these, four are associated with a principal structure that is listed as protected within the Galway City Development Plan. The landscapes are shown as shaded 'demesne' landscapes on the first edition OS mapping. These environments were intended to represent a natural parkland setting for a large house, a practice that became fashionable from the latter part of the 18th Century onwards. The landscapes, which can vary greatly in size, often possess specific features, such as long driveways, gate lodges, stately entrances, walled gardens, bodies of water and belts, avenues and clumps of deciduous and specimen trees.

The identified designed landscapes are listed in **Table 13.7** and described in more detail in **Appendix A.13.5** of this EIAR and shown on **Figures 13.1** to **13.14**.

Table 13.7: Designed Landscapes (DL) located within the receiving environment

DL No.:	Townland:	Description:
DL 1	Bearna, Cluain na nGabhar, Gort na Leice, An Roisín, An Seanbhaile Dubh, Baile an Mhóinín Thoir	Barna House and demesne. Marked as a substantial demesne on the first edition OS map covering several townlands. NIAH garden survey lists it as 'Main features unrecognisable – peripheral features visible'[25]. Barna House is a protected structure. The northwest corner of the demesne is located c. 143m southeast of the proposed road development.
DL 2	Rahoon	Rahoon House and demesne. The house and a large demesne landscape are marked on the first edition OS map. The principal structure does survive today and is a protected structure (BH 18), but is surrounded by modern residential development. As such, the demesne has almost completely lost its original character. NIAH garden survey lists it as 'Virtually no recognisable features'[26]. A proposed link road will run through the northwest corner of the original demesne.
DL 3	Kentfield	Glenlo Abbey demesne. The house is named as 'Glenlough' on the first edition OS map and occupies a large demesne landscape. The early 20th Century map shows it renamed as 'Glenlo Abbey'. The NIAH garden survey records it as 'Main features unrecognisable – peripheral features visible'[27]. The principal structure is not a protected structure. The southeast corner of the demesne is located to the immediate north of the proposed road development where it extends along the N59 Moycullen Road.
DL 4	Bushypark	Bushypark House demesne. Marked on the first edition OS map as a modest demesne. The NIAH garden survey lists it as 'Main features substantially present – peripheral features unrecognisable'[28]. The principal structure is still extant (BH 5) and is listed as a protected structure. The proposed link road will terminate to the immediate southwest of the demesne and associated drainage infrastructure will extent through the eastern portion of the demesne.
DL 5	Barnacranny	Lake View House and demesne. Shown on the first edition OS map but not shaded. Not included within the NIAH garden survey. The house is still extant today but the garden has been

[25] NIAH Garden Ref.: GA-45-M-248237
[26] NIAH Garden Ref.: GA-45-M-273253
[27] NIAH Garden Ref.: GA-45-M-267283
[28] NIAH Garden Ref.: GA-45-M-272278

DL No.:	Townland:	Description:
		impacted upon by modern residential development (CH 39). The north-eastern side of the demesne is located to the immediate south of the proposed road development where it extends along the N59 Moycullen Road.
DL 6	Dangan Upper	Ashley Park demesne. This house is marked within a demesne landscape on the first edition OS map. The NIAH garden survey records it as 'possessing virtually no recognisable features'[29]. Whilst the principal structure remains extant today (CH 40, the remainder of the landscape has been covered with residential development. The north-eastern side of the demesne is located to the immediate south of the proposed road development where it extends along the N59 Moycullen Road.
DL 7	Dangan Lower	Dangan Cottage, Dangan House, Dangan Nunnery, Mary Ville demesnes. The first edition OS map shows a large demesne landscape containing a number of large structures although the boundaries between them are not clear. The NIAH garden survey only includes an entry for Dangan House (which actually refers to Dangan Cottage). It reports 'virtually no recognisable features remain'[30]. The proposed road development travels in a north-east direction through the original demesne lands.
DL 8	Mionlach	Menlo Castle Demesne. The NIAH garden survey records it as 'Main features unrecognisable – peripheral features visible'[31]. Today the principal structure survives in ruins on the site (BH 10) and there has been a small amount of modern development in the northern part of the demesne. For the most part it remains as green fields, although has been subject to division to suit farming requirements. Some woodland survives within the former demesne, but only a small percentage when compared to the historic mapping. The principal structure and its entrance are both protected structures. The proposed road development travels in a north-east direction through the original demesne lands. The western part of the original demesne is located within an area of proposed for habitat enhancement.
DL 9	Ballybrit	Ballybrit House demesne. Today the demesne is completely covered by development and a road and as such nothing survives. The NIAH garden survey

[29] NIAH Garden Ref.: GA-45-M-283271
[30] NIAH Garden Ref.: GA-45-M-284274
[31] NIAH Garden Ref.: GA-45-M-284278

DL No.:	Townland:	Description:
		lists the area as possessing 'virtually no recognisable features'[32]. A short section of proposed existing infrastructure upgrade in located in the northeast corner of the original demesne landscape location.

13.3.1.8 Summary of Previous Archaeological Investigations within the Receiving Environment

A review of the Excavations Bulletin (1970 – 2016) has revealed that a number of archaeological investigations have been carried out within the receiving environment of the proposed road development. These are summarised below in **Table 13.8**.

Table 13.8: Summary of Previous Archaeological Fieldwork carried out within the receiving environment

Excavations Bulletin Ref.:	Licence Ref.:	Townland:	Description:
2001:497	01E0992	Coolagh/ An Caisleán Gearr/ Ballybrit/ Parkmore/ Cappanabornia/ Glenanail/ Ballybaan Beg,	Nothing of archaeological significance was identified during the course of monitoring 4.1km of pipeline construction.
2002:0724	02E1327	Dangan Lower	Archaeological testing adjacent to a recorded ring barrow (AH 11) revealed no features of archaeological significance.
2005:579 & 2006:779	Ministerial Dir.: A024/1.3 & A024/5 E2435	Coolagh	Archaeological testing and full excavation was carried out prior to the development of the existing N6. A possible cashel (53m x 60m) was identified in the townland of Coolagh within the footprint of the proposed road development (although an associated annex wall was noted to the south of the proposed development boundary). A secure date for the site was not obtained due to the lack of stratified finds. However, a red bead and fragments of lignite bracelet as well as two possible lime kilns were noted within the interior along with the oval foundations of a stone structure. It is possible the site represents an earlier medieval cashel. The site is located to the immediate east of the eastern end of the proposed road development where it extends along the existing N6.

[32] NIAH Garden Ref.: GA-46-M-333272

Excavations Bulletin Ref.:	Licence Ref.:	Townland:	Description:
2000:0368	00E0144	Ballinfoyle, Glenanail, An Caisleán Gearr	Monitoring of the Terryland drainage scheme in the landscape to the north of the existing N6 failed to identify any features of archaeological significance.
2005:592 2006:790	A024/1.1 E2052	Doughiska	A series of burnt mounds were found during testing and then excavated immediately adjacent to the current proposed road development (AH 36), as part of an earlier phase of construction associated with the existing N6. Only one shallow pit was found with the remains. Presumed to be prehistoric in date.
2008:540	E3588	Doughiska	During monitoring associated with the construction of the existing N6, a well was identified c. 100m SSW of the current proposed road development. It was deemed to be post medieval in date.
2012:279	12E0055	Na hAille, An Cheapach	Nothing of archaeological significance discovered during monitoring associated with an 110kv electricity line.
1997:194	97E0341	An Caisleán Gearr	Archaeological testing to the immediate west of AH 25/BH 13 failed to identify any features of archaeological significance.
1998:237	98E0498	An Caisleán Gearr	In 1998 archaeological testing was carried out at the site of a souterrain, which was identified in 1967 c.100m south of the current proposed road development. Reports of the time (1968) also indicated the discovery of a number of skeletons. However, testing in 1998 in the area failed to identify any archaeology – it is possible that previously identified archaeological remains were removed during the intervening years during land clearance.
N/a	14R0089	Ballybrit	As part of the constraints and route selection stage of the proposed road development, a geophysical survey was carried out at the centre of Galway Racecourse at Ballybrit in 2014. Both magnetometry & targeted electromagnetic induction (quadrature) survey were carried out. The survey indicated that widespread disturbance had taken place across the site. Some potential archaeological anomalies were noted in small areas across the site, but no responses were noted as being definitively archaeological.

13.3.1.9 Aerial Photographic Analysis

Analysis of a number of aerial photographic data sets was carried out as part of this appraisal. These included:

- Google Earth vertical aerial photographs, 2003, 2005, 2006, 2007, 2009, 2011, 2012
- Ordnance Survey Ireland vertical aerial photographs, 1995, 2000, 2005
- Bing.com vertical aerial photographs (Digital Globe), 2012

One site of archaeological potential was identified within the townland of Mionlach. This consists of a discrete circular anomaly visible within the Digital Globe data set (CH 46). The anomaly corresponds to a circular feature depicted on the 25-inch OS mapping (1895 – 1900). This feature may relate to the demesne landscape (DL 8) associated with Menlo Castle (AH 11/ BH 2).

13.3.1.10 Results of Field Inspection

The field inspection sought to assess the route of the proposed road development, its previous and current land use, the topography and to confirm the presence of any areas or sites of archaeological potential. During the course of the field investigation the full extent of the route of the proposed road development, and, where practicable, its immediate surrounding environs were inspected for known or previously unknown archaeological sites. The inspection was carried out in windy and wet conditions between the 30 of November to the 04 of December 2015 and during sunny conditions on the 26 of July 2016.

The route of the proposed road development traverses approximately 16.8km of ground which describes a generally northeast- southwest arcing corridor from the townland of An Baile Nua west of Bearna to Coolagh to the east of Galway City. The proposed road development traverses, for the most part, undeveloped, agricultural land. Extended areas of the route of the proposed road development are overgrown with gorse and bramble. The proposed road development is divided into two distinct sections by the River Corrib at Dangan/Menlough. This watercourse also represents the boundary of a clear geological divide between the western and eastern sections of the proposed road development. To the west of the N59 Moycullen Road, the underlying geology is granite and the landscape is characterised by a pattern of irregularly shaped, undulating enclosed fields delineated by drystone granite walls. Stretches of exhausted blanket bog are also common and many fields, particularly in the vicinity of Bearna have been left fallow and are entirely overgrown and inaccessible. To the east of the River Corrib, the underlying geology is limestone and the landscape is characterised by a pattern of larger, generally rectangular fields of improved bog pasture. The notable exceptions to this pattern were encountered within the overgrown demesne landscape of Menlough which comprises small overgrown fields covered in dense hazel and ivy growth and in the vicinity of the limestone quarry in Coolough, Lackagh Quarry, where extended areas of bare limestone pavement were observed.

A full record of the field inspection, including a summary of those areas that were not accessible, is included in **Appendix 13.6** of this EIAR. Photographs illustrating a variety of sites are included in **Appendix 13.7** and the route of the proposed road development and various sites are shown on **Figures 13.1.01** to **13.1.14**.

13.3.1.11 Previously Unrecorded Sites/ Structures of Cultural Heritage Merit

A number of previously unrecorded sites and structures of archaeological and architectural heritage merit have been identified during the course of this appraisal through the analysis of historic mapping, aerial photographs and field inspections. In order to reflect the fact that these sites are not subject to statutory protection, they have been listed as Cultural Heritage sites (CH). These are included in **Table 13.9** and shown on **Figures 13.1.01** to **13.1.14**.

Table 13.9: Previously Unrecorded sites of Cultural Heritage merit located within the receiving environment

CH No.	Townland:	Description:	Approx. Ch.	Dist. from proposed road development
CH 1	Na Foraí Maola Thiar	Site of vernacular structures marked on 1841 first edition map. No longer extant	0+150	15m west
CH 2	Na Foraí Maola Thiar	Site of vernacular structures marked on 1841 first edition OS map. No longer extant	0+130	0m
CH 3	Na Foraí Maola Thiar	Single storey vernacular cottage marked on the 1895 – 1900 25" OS map	0+175	145m east
CH 4	Na Foraí Maola Thiar	Sub-circular stone enclosure (Also AH 1 redundant record)	0+500	7m east
CH 5	Na Foraí Maola Thiar	Site of ruined vernacular structures marked on the 1841 first edition OS map	0+450	72m east
CH 6	Troscaigh Thiar	Single storey vernacular cottage marked on the 1895 – 1900 25" OS map	1+550	77m north-northwest
CH 7	Na Foraí Maola Thoir	Single storey vernacular cottage marked on the 1841 first edition OS map	1+500	10m south
CH 8	Troscaigh Thiar	Walled laneway marked on the 1841 first edition OS map	1+950	0m
CH 9	Troscaigh Thiar	Possible famine bridge	1+650	119m northeast
CH 10	Troscaigh Thiar	Site of a post medieval sheep fold. No longer extant	2+110	0m
CH 11	Troscaigh Thiar	Single storey vernacular cottage marked on the 1895 – 1900 25" OS map	2+250	17m west

CH No.	Townland:	Description:	Approx. Ch.	Dist. from proposed road development
CH 12	Troscaigh Thiar	Ruins of a vernacular building marked on the 1895 – 1900 25” OS map	2+150	140m west
CH 13	Troscaigh Thoir	Vernacular cottage and associated farm buildings. Some marked on the 1841 first edition OS map	2+400	33m south
CH 14	An Chloch Scoilte	Vernacular cottage. Marked on the 1895 – 1900 25” OS map	2+700	102m northwest
CH 15	An Chloch Scoilte	Ruins of a vernacular cottage. Marked on the 1895 – 1900 25” OS map.	2+800	210m north
CH 16	An Chloch Scoilte	The ruinous remains of the post medieval settlement of An Chloch Scoilte. The first edition OS map shows 18 structures in this area. By the time of the 1895-1900 25” OS map only six structures remain with a further two shown in ruins. Today four ruined structures survive along with one cottage that is still inhabited	2+900	191m north
CH 17	Troscaigh Thoir	Vernacular cottage, now extended. Marked on the 1895 –1900 25” OS map	3+075	146m south-southeast
CH 18	An Chloch Scoilte	Vernacular cottage, now extended. Marked on the 1895 –1900 25” OS map	3+260	0m
CH 19	An Cheapach	Vernacular cottage and associated farm building. Marked on the 1841 first edition OS map	4+350	116m north-northwest
CH 20	An Cheapach	Vernacular cottage and outbuildings. Marked on the 1895 – 1900 25” OS map	4+340	10m south
CH 21	An Cheapach	Site of vernacular structures marked on the 1841 first edition OS map. No longer appears to be extant	4+520	14m north
CH 22	An Cheapach	Group of ruined vernacular structures marked on the 1841 first edition OS map	4+450	20m east
CH 23	An Cheapach	Vernacular cottage marked on the 1895 – 1900 25” OS map. Now derelict but is upstanding and retains its pitched slate roof	4+600	6m southeast
CH 24	Ballynahown East	Ruins of a vernacular cottage marked on the 1841 first edition OS map	4+900	35m southeast

CH No.	Townland:	Description:	Approx. Ch.	Dist. from proposed road development
CH 25	Keeraun	Vernacular farm yard marked on the 1841 first edition OS map and the 1895 – 1900 25" OS map	5+500	24m northwest
CH 26	Keeraun	Vernacular cottage marked on the 1895 – 1900 25" OS map. Extended to the east with several concrete structures with corrugated roofs but the main cottage is now derelict	5+650	0m
CH 27	Keeraun	Vernacular cottage marked on the 1895 – 1900 25" OS map	5+700	23m west-northwest
CH 28	Keeraun	Vernacular cottage marked on the 1895 – 1900 25" OS map	5+900	217m north-northeast
CH 29	Mincloon	Site of vernacular structures marked on 1841 first edition OS map. No longer extant	6+300	0m
CH 30	Mincloon	Vernacular house and farmstead, marked on the 1895 – 1900 25" OS map	6+450	13m west
CH 31	Mincloon	A number of vernacular outbuildings marked on the 1895-1900 second edition OS map	6+500	75m east-southeast
CH 32	Mincloon	A stone outbuilding marked on the 1915 – 20 third edition OS map	6+500	0m
CH 33	Rahoon	Very well-built stone-walled laneway, marked on the 1841 first edition OS map	6+975	0m
CH 34	Rahoon	Site of vernacular structures marked on 1841 first edition OS map. No longer extant	7+280	0m
CH 35	Rahoon	Leitriff House. Two-storey farm house with four bays. Named and extended on 1895 – 1900 25" OS map	7+350	88m southeast
CH 36	Letteragh	A very well-built stone-walled laneway, marked on the 1841 first edition OS map	7+410	0m
CH 37	Dangan Upper	Well-built cairns from stone clearance. Not marked on the OS maps	7+600	0m
CH 38	Ballagh	Possible square enclosure. Not marked on the OS maps	N59 Link Road North 0+150	0m
CH 39	Barnacranny	Lake View House. Recently renovated two storey house.	8+350	39m southeast

CH No.	Townland:	Description:	Approx. Ch.	Dist. from proposed road development
		Marked on the 1841 first edition OS map		
CH 40	Dangan Upper	Ashley Park. Single storey house marked on the 1841 first edition OS map	8+700	19m southeast
CH 41	Dangan Lower	Mary Ville. Single storey house over rear basement with outbuildings. Marked on the 1895 – 1900 25” OS map	8+950	15m east
CH 42	Dangan Lower	Ruined stone outbuilding that is marked on the 1895 – 1900 25” OS map	8+725	8m southeast
CH 43	Dangan Lower	Site of Dangan Cottage. Marked on the 1841 first edition OS map, in ruins by the 1895 – 1900 25” OS map	8+800	27m southeast
CH 44	Dagan Lower	Site of walled garden and outbuildings associated with Dangan House (Nunnery). Shown the 1841 first edition OS map	9+100	38m northwest
CH 45	Mionlach	Possible boating inlet off the River Corrib. Shown on the 1895 – 1900 25” OS map but not annotated	9+450	33m southeast
CH 46	Mionlach	Possible circular enclosure identified during AP analysis and marked as a possible feature on the 1895-1900 25” OS map	9+600	28m southeast of alignment (within proposed habitat enhancement for bats)
CH 47	Mionlach	Possible vernacular animal shelter. Not marked on the historic mapping (2006 EIS)	9+700	34m northwest
CH 48	Mionlach	Possible consumption wall (2006 EIS)	9+600	24m northeast
CH 49	Mionlach	Possible prehistoric tomb (2006 EIS)	9+850	0m
CH 50	Mionlach	Possible circular feature (2006 EIS)	10+375	56m south
CH 51	Mionlach	Possible boulder of archaeological potential (2006 EIS)	10+500	0m
CH 52	Mionlach	Site of vernacular structures marked on the 1841 first edition OS map. No longer appear to be extant	10+600	0m
CH 53	An Caisleán Gearr	Ruins of a vernacular structures marked on the 1841 first edition OS map	13+225	97m south-southeast

CH No.	Townland:	Description:	Approx. Ch.	Dist. from proposed road development
CH 54	An Caisleán Gearr	Vernacular cottage marked on the 1895 – 1900 25” OS map	13+775	39m north
CH 55	Parkmore	Site of vernacular structures marked on 1895 – 1900 25” OS map. No longer extant	13+925	0m
CH 56	Parkmore	Site of vernacular structures marked on 1895 – 1900 25” map. No longer extant	14+120	0m
CH 57	Parkmore	Possible mass path. Sections of which are shown within historic mapping but not annotated	14+200	0m
CH 58	Coolagh	Site of vernacular structures, including a school, marked on the 1841 first edition OS map and the 1895 – 1900 25” OS map. No longer extant	15+850	0m
CH 59	Breanloughaun	Vernacular outbuilding. Marked on the 1895 – 1900 25” OS map	15+800	150m east-northeast
CH 60	Coolagh	Two storey vernacular farm house and associated outbuilding. Marked within the 25” OS map	16+400	169m northeast
CH 61	Coolagh	Renovated vernacular cottage and outbuilding. Marked on the 1895 – 1900 25” OS map	16+550	260m northeast
CH 62	Coolagh	Group of vernacular buildings comprising two single storey cottages, a two storey house and several outbuildings. One of the cottages is marked on the first edition OS map of 1841 and the remaining structures are shown on the 1895 – 1900 25” OS map. The structures are all upstanding but vary in condition	16+625	188m northwest
CH 63	Bushypark	Ruins of a vernacular structure shown on the 1895 – 1900 25” map	N59 Link Road North 0+000	3m northeast
CH 64	Letteragh	Vernacular cottage, now extended. Marked on the 1895 – 1900 25” OS map	N59 Link Road South 1+575	113m southeast
CH 65	Letteragh	Ruins of a vernacular cottage marked on the 1895 – 1900 25” OS map	N59 Link Road South 1+600	229m east-southeast
CH 66	Rahoon	Vernacular house, recently renovated. Marked on the 1895 – 1900 25” OS map	N59 Link Road	159m west-northwest

CH No.	Townland:	Description:	Approx. Ch.	Dist. from proposed road development
			South 2+050	
CH 67	Dangan Lower	Dangan House. A mid-19th century house in good condition. Likely under construction during compilation of the first edition OS map, as the structure is present but not labelled. By the time of the 1895 – 1900 25” OS map it is shown with outbuildings and annotated as ‘Dangan House’	9+100	199m southeast
CH 68	Bushypark	Disused railway	Pipeline wayleave	0m
CH 69	Bushypark	Potential mass rock	Pipeline wayleave	30m west-northwest
CH 70	Bushpark / Dangan Lower	Railway culvert	Pipeline wayleave	To the immediate east
CH 71	Mincloon	Walled trackway	6+200	0m
CH 72	Mionlach	Walled trackway	9+800	0m

13.3.1.12 Areas of Archaeological Potential (AAPs)

A number of areas of archaeological potential have been identified during the course of this appraisal through the analysis of historic mapping, aerial photographs and field inspections. These consist of features or areas within the receiving environment that often attract human activity, such as watercourses. The areas are described in **Table 13.10**.

Table 13.10: Areas of Archaeological Potential located within the receiving environment

AAP No.:	Townland:	Description:	Approx. Ch.	Dist. from proposed road development
AAP 1	Na Foraí Maola Thiar/ Cnoc na Gréine	Liberty Stream (TB 2)	0+430 - 0+650	0m
AAP 2	Troscaigh Thoir/ An Chloch Scoilte	Trusky Stream (TB 6)	2+650 - 2+950	0m
AAP 3	Na hAille/ An Cheapach	Barna Stream (TB 10)	3+850 - 4+150	0m
AAP 4	Ballynahown East	Stream (TB 12)	4+800 - 5+200	0m
AAP 5	Rahoon	Stream and boggy hollow	6+800 - 6+900	0m
AAP 6	Rahoon	Small stream	7+300 - 7+375	0m

AAP 7	Barnacranny	Small stream	7+500 - 7+675	0m
AAP 8	Barnacranny	Boggy, waterlogged marginal lands	N59 Link Road North 0+500 to 0+850	0m
AAP 9	Dangan Lower/ Mionlach	River Corrib (TB 22)	9+175 - 9+525	0m
AAP 10	An Caisleán Gearr	Boggy pasture – margins of *Lough an Dúlaigh*	12+200 - 12+450	0m
AAP 11	An Caisleán Gearr	Boggy hollow (AH 24)	12+975 - 13+075	0m
AAP 12	Bushypark	Site of 'Loughaunnafraska'	Pipeline wayleave	0m

13.3.1.13 Townland Boundaries

The proposed road development traverses a total of 33 townlands, three parishes and two baronies as listed in **Table 13.3**.

The townland is an Irish land unit of considerable longevity as many of the units are likely to correspond to much earlier land divisions. However, the term townland was not used to denote a unit of land until the Civil Survey of 1654. It bears no relation to the modern word 'town' but like the Irish word *baile* refers to a place. It is possible that the word is derived from the Old English *tun land* and meant 'the land forming an estate or manor' (Culleton 1999, 174).

Gaelic land ownership required a clear definition of the territories held by each sept[33] and a need for strong, permanent fences around their territories. It is possible that boundaries following ridge tops, streams or bog are more likely to be older in date than those composed of straight lines (*ibid.* 179).

The vast majority of townlands are referred to in the 17th Century, when land documentation records begin. Many of the townlands are mapped within the Down Survey of the 1650s, so called as all measurements were carefully 'laid downe' on paper at a scale of forty perches[34] to one inch. Therefore, most are in the context of pre-17th Century landscape organisation (McErlean 1983, 315).

In the 19th Century, some demesnes, deer parks or large farms were given townland status during the Ordnance Survey and some imprecise townland boundaries in areas such as bogs or lakes, were given more precise definition (*ibid.*). Larger tracks of land were divided into a number of townlands, and named Upper, Middle or Lower, as well as Beg and More (small and large) and north, east, south and west (Culleton 1999, 179). By the time the first Ordnance Survey had been completed a total of 62,000 townlands were recorded in Ireland.

The proposed road development will traverse 31 townlands. Some of the boundaries follow natural watercourses, but many were defined properly in the 19th Century

[33] A sept is a group or clan
[34] 1 perch = 5.0292m

and are marked with dry stone walls. The development of road infrastructure and the expansion of Galway City has already impacted upon the landscape and in some circumstances the townland boundaries are no longer extant.

Table 13.11: Townland Boundaries crossed by the proposed road development

TB No.:	Townland:	Description:	Approx. Ch.	Dist. from proposed road development
TB 1	An Baile Nua/ Na Foraí Maola Thiar	Sea Road (R336)	0+000	0m
TB 2	Na Foraí Maola Thiar/ Cnoc na Gréine	Liberty Stream (Also AAP 1)	0+450 – 0+650	0m
TB 3	Na Foraí Maola Thiar/ Na Foraí Maola Thoir	Local Road	1+100	0m
TB 4	Na Foraí Maola Thoir/ Troscaigh Thiar	Local Road	1+550	0m
TB 5	Troscaigh Thiar/ Troscaigh Thoir	Hedgerow & modern fence	2+425	0m
TB 6	Troscaigh Thoir/ An Chloch Scoilte	Former site of townland boundary including a portion of stream (AAP 2)	2+650 - 2+850	0m
TB 7	Troscaigh Thoir/ An Chloch Scoilte/ Ballard West	Stone wall	2+975 - 3+200	0m
TB 8	Ballard West/ Ballard East/ An Chloch Scoilte	Local road. Boundary between Ballard West and East not extant	3+250 - 3+350	0m
TB 9	Ballard East/ Na hAille	Stone wall	3+490	0m
TB 10	Na hAille/ An Cheapach	Barna Stream (AAP 3)	4+100	0m
TB 11	An Cheapach/ Ballynahown East	Stone walled laneway	4+700 – 4+800	0m
TB 12	Ballynahown East/ Keeraun	Stream (AAP 4) and field boundary (boundary completely overgrown)	4+800 – 5+250	0m
TB 13	Keeraun/ Ballyburke	Stone wall and hedgerow	5+660 – 5+725	0m
TB 14	Ballyburke/ Mincloon	Stone wall	6+050	0m
TB 15	Mincloon/ Rahoon	Stone wall	6+800	0m
TB 16	Rahoon/ Letteragh	Stone wall, sections of which have been removed	7+400	0m
TB 17	Letteragh/ Barnacranny	Stone wall	7+550	0m

TB 18	Barnacranny/ Dangan Upper	Stone wall	7+740	0m
TB 19	Barnacranny/ Dangan Upper	No access granted	8+200	0m
TB 20	Dangan Upper/ Dangan Lower/ Kentfield/ Ballagh/ Bushypark	N59 Moycullen Road (crossed at 2 points)	8+525	0m
TB 21	Barnacranny/ Ballagh	Stone wall and ditch	N59 Link Road North 0+550	0m
TB 22	Dangan Lower/ Menlough	River Corrib (AAP 9)	9+350	0m
TB 23	Mionlach /Ballindooley	Stone wall	10+725	0m
TB 24	Coolagh/ Ballindooley/ An Caisleán Gearr	Quarried away	11+600	0m
TB 25	Ballindooley/ An Caisleán Gearr	Stone wall and hedgerow	11+600 – 12+250	0m
TB 26	An Caisleán Gearr/ Parkmore	Tuam Road	13+900	0m
TB 27	An Caisleán Gearr/ Cappanabornia	Hedgerow	13+840	0m
TB 28	Cappanabornia/ Parkmore	Tuam Road	13+840	0m
TB 29	Parkmore/ Pollkeen	Stone wall	14+350	0m
TB 30	Parkmore/ Ballybrit	Removed	14+750	0m
TB 31	Ballybrit/ Doughiska	Removed	15+600	0m
TB 32	Doughiska/ Coolagh/ Breanloughaun	Stone wall and road	15+750 – 16+800	0m
TB 33	Rahoon/ Letteragh	Stone wall	N59 Link Road South 1+620	0m

13.3.1.14 Analysis of placenames within the receiving environment

Townland and topographic names are an invaluable source of information on topography, landownership and land use within the landscape. They also provide information on history; archaeological monuments and folklore of an area. A place name may refer to a long-forgotten site, and may indicate the possibility that the remains of certain sites may still survive below the ground surface. The Ordnance Survey surveyors recorded townland names in the 1830s and 1840s, when the entire country was mapped for the first time. Some of the townland names in the study area are of Irish origin and through time have been anglicised. The main references used for the place name analysis is *Irish Local Names Explained* by P.W Joyce (1870) and the Place Names Database of Ireland. A description and possible explanation of each townland name in the environs of the proposed road development are provided in the below table.

Table 13.12: Townland Names within the study area

Name (English)	Name (Irish)	Derivation	Possible Meaning
New Village	An Sráidbhaile Nua	N/a	Likely to relate to establishment of Bearna Village
Forramoyle East & West	Na Foraí Maola Thoir & Thiar	*Fauran-maola*	Spring on the flat topped hillock
Trusky West & East	Troscaigh Thiar & Thoir	*Triucha*	A cantred or district
Cloghscolita	An Chloch Scoilte	*Chloch-scoilte*	The split stone
Ballard West & East	An Baile Ard Thiar & Thoir	*Baile-ard*	The high town
Aille	An Aill	*Aill*	The cliff
Cappagh	An Cheapach	*Ceapach*	Plot of tillage land
Ballynahown East	Baile na hAbhann Thoir	*Baile-na-hAbhann*	Town of the river
Keeraun	An Caorán	*Caorán*	Moorland
Mincloon	Mionchluain	*Meen-cluain*	The small or fine meadow
Rahoon	Ráthún	*Rath-ún*	The fort
Letteragh	Leitreach	*Leitreach*	The hillside
Ballagh	An Bealach	*Bealach*	The way/pass
Kentfield	Baile an Cheantaigh	N/a	Likely to relate to the name of a landowner
Bushypark	Páirc na Sceach	*Bohy-pairc*	Field of the hut or tent
Dangan Lower & Upper	An Daingean Íochtair & Uachtair	*Daingean*	A fortress
Barnacranny	Barr na Crannaí	*Barr-na-crann*	Top of the tree
Menlough	Mionlach	*Meen-lach*	The small or smooth lake
Castlegar	An Caisleán Gearr	*Caisleán-Gearr*	The short castle
Ballindooley	Baile an Dúlaigh	*Baile-an-Dúlaigh*	Town/Homestead of Dúlaigh
Cappanabornia	Ceapach na Boirne	*Ceapach-na-boirne*	Land of the burren (area of rocky land)
Parkmore	An Pháirc Mhór	*Pháirc-mór*	The large field

Name (English)	Name (Irish)	Derivation	Possible Meaning
Ballybrit	Baile an Bhriotaigh	*Baile-an-Bhriotaigh*	The town of the Britons
Pollkeen	An Poll Caoin	*Poll-caoin*	The pleasant hole
Doughiska	Dabhach Uisce	*Dabhach-uisce*	The water tank
Breanloughaun	An Bréanlochán	*Bréan-lochán*	The foul lake
Coolagh	An Chuailleach	*Cualacha*	Corner field

13.3.1.15 Results of Geophysical Survey

As part of the assessment, a geophysical survey was carried out within one area of potential identified during the baseline assessment and field inspection. This area is located within the townland of Bushypark and the survey area included an area adjacent to a church and graveyard (BH 7) and a previously unknown platform in the landscape that may possess archaeological potential (CH 38).

The geophysical survey was carried out by Earthsound Archaeological Geophysics on behalf of IAC Ltd for Galway County Council and TII. It took place on the 17 and 18 of November 2016 under licence 16R0190. Magnetometer and EM Apparent Electrical Resistance surveys were conducted.

The survey revealed a number of possible ditches across the survey area. Many of these are linear in formation and are likely to form boundary features. The resistance survey suggests that some may have a bank or wall feature associated with them. A series of relict field boundaries were also detected.

Possible archaeological evidence includes a number of possible burning or industrial sites, a sub-rectangular ditch and ditches. Further anomalies are likely to be associated with soil or geological conditions on site and / or near surface geological outcrops. No anomalies were detected which appear to be associated with Bushypark Church and no evidence can be seen to suggest that the associated graveyard extends into the survey area. The full report has been included as **Appendix 13.12**.

13.4 Characteristics of the Proposed Development

13.4.1 Construction Phase

A detailed description of the proposed road development and construction activities are provided in **Chapter 5, Description of Proposed Road Development** and **Chapter 7, Construction Activities**. The characteristics of the proposed road development at construction stage, in relation to archaeology, architectural and cultural heritage, will involve the excavation of those lands made available (within the proposed development boundary) in order to facilitate the construction of the proposed road development. Physical changes to the existing ground level, including water courses, has the potential to impact on archaeological, built heritage and cultural heritage sites. The potential impacts related to such characteristics are provided in **Section 13.5** and detail on how impacts may occur is provided in **Appendix A.13.10**.

13.4.2 Operational Phase

At the operational stage of the proposed road development there is the potential to impact on the settings of archaeological, built and cultural heritage sites, due to physical changes to the receiving environment. The potential impacts related to such characteristics are provided in **Section 13.5** and detail on how impacts may occur is provided in **Appendix A.13.10**.

13.5 Evaluation of Impacts

13.5.1 Introduction

The evaluation of the potential impacts on archaeology, architectural and cultural heritage was undertaken in accordance with the criteria set out in **Section 13.2.4**. A summary of all sites, structures, potential impacts and proposed mitigation is included in **Tables 13.21** to **13.26** in **Section 13.8**.

13.5.2 Do-Nothing Impact

If the proposed road development were not to proceed, there would be no adverse impact on the archaeological, architectural and cultural heritage resource.

13.5.3 Potential Construction Impacts

Ground disturbances associated with the construction of the proposed road development, such as the removal of topsoil and the excavation of those lands made available have the potential to directly and negatively impact on the following sites (**Table 13.13**). No indirect impacts arising from vibration or dust associated with construction activities are anticipated.

This represents the recommended assessment of significance and impact descriptions for the purposes of informing the overall assessment of the likely impact on the archaeological, architectural and cultural heritage.

Table 13.13: Archaeological Heritage (AH): Potential Construction Impacts

Impact Significance						
Profound	Very Significant	Significant	Moderate	Slight	Not Significant	Imperceptible
AH 2 Bullaun Stone	-	-	**AH 27** Quarry	-	-	-

Table 13.14: Built Heritage (BH): Potential Construction Impacts

Impact Significance						
Profound	Very Significant	Significant	Moderate	Slight	Not Significant	Imperceptible
BH 12 Thatched cottage	-	-	-	-	-	-

Table 13.15: Designed Landscapes (DL): Potential Construction Impacts

Impact Significance						
Profound	Very Significant	Significant	Moderate	Slight	Not Significant	Imperceptible
-	-	**DL 8** Menlo Castle demesne	**DL 7** Dangan Lower demesnes **DL 4** Bushypark House demesne	-	-	**DL 2** Rahoon House demesne

Table 13.16: Cultural Heritage (CH): Potential Construction Impacts

Impact Significance						
Profound	Very Significant	Significant	Moderate	Slight	Not Significant	Imperceptible
-	-	**CH 2** Site of vernacular buildings **CH 18** Vernacular cottage **CH 26** Vernacular cottage	**CH 8** Walled laneway **CH 10** Site of sheep fold **CH 32** Stone outbuilding **CH 33** Walled laneway **CH 36** Walled laneway	-	-	-

Impact Significance						
Profound	Very Significant	Significant	Moderate	Slight	Not Significant	Imperceptible
		CH 29 Site of vernacular buildings **CH 34** Site of vernacular building **CH 38** Possible square enclosure **CH 49** Possible prehistoric tomb **CH 52** Site of vernacular buildings **CH 55** Site of vernacular buildings **CH 56** Site of vernacular buildings **CH 57** Possible mass path **CH 58** Site of vernacular buildings	**CH 37** Clearance cairns **CH 51** Possible boulder of arch. Significance **CH 71** Walled track **CH 72** Walled track **CH 68** Disused railway **CH 70** Railway Culvert			

Areas of Archaeological Potential

Ground disturbances associated with the proposed road development have the potential to have a moderate, significant or profound direct and negative impact on as yet undiscovered archaeological features, deposits or artefacts that have the potential to survive beneath the current ground surface or water level within designated AAPs 1-12.

Townland Boundaries

Ground disturbances associated with the proposed road development have the potential to have a moderate direct and negative impact on sections of the 33 townland boundaries located within the proposed development boundary of the proposed road development.

General

Ground disturbances associated with the proposed road development have the potential to have a moderate, significant or profound direct and negative impact on archaeological features, deposits or artefacts that have the potential to survive beneath the current ground surface with no surface expression.

13.5.4 Potential Operational Impacts

The operation of the proposed road development has the potential to indirectly and negatively impact on the following sites:

Table 13.17: Archaeological Heritage (AH): Potential Operation Impacts

Impact Significance						
Profound	Very Significant	Significant	Moderate	Slight	Not Significant	Imperceptible
-	-	**AH 15** Summer house **AH 16** Menlo Castle	**AH 29** Cashel etc.	**AH 11** Barrow **AH 12** Site of House **AH 23** Site of chapel **AH 26** Children's burial ground	-	**AH 8** Children's burial ground **AH 14** Designed landscape feature

Table 13.18: Built Heritage (BH): Potential Operation Impacts

Impact Significance						
Profound	Very Significant	Significant	Moderate	Slight	Not Significant	Imperceptible
-	-	**BH 9** Summer house **BH 10** Menlo Castle	**BH 1** Thatched cottage **BH 7** Church **BH 17** Cashel etc.	**BH 2** Thatched cottage **BH 5** Bushypark House **BH 14** Site of chapel	-	**BH 15** Two ruined cottages

Table 13.19: Designed Landscapes (DL): Potential Operation Impacts

Impact Significance						
Profound	Very Significant	Significant	Moderate	Slight	Not Significant	Imperceptible
-	-	**DL 8** Menlo Castle demesne	**DL 7** Dangan Lower demesnes	**DL 4** Bushypark House demesne	-	**DL 2** Rahoon House demesne

Table 13.20: Cultural Heritage (CH): Potential Operation Impacts

Impact Significance						
Profound	Very Significant	Significant	Moderate	Slight	Not Significant	Imperceptible
-	-	**CH 20** Vernacular buildings **CH 23** Vernacular cottage	**CH 4** Sub-circular enclosure **CH 25** Vernacular buildings **CH 30** Vernacular complex **CH 35** Leitriff House **CH 42** Stone outbuilding **CH 54** Vernacular Cottage	**CH 7** Vernacular cottage **CH 19** Vernacular buildings **CH 21** Site of vernacular buildings **CH 22** Ruined vernacular buildings **CH 24** Ruined vernacular building **CH 39** Lakeview House **CH 45** Possible boat inlet **CH 47** Vernacular animal shelter **CH 50** Possible circular feature **CH 53** Ruined vernacular buildings **CH 60** Vernacular complex **CH 61** Vernacular cottage **CH 62** Vernacular complex **CH 67** Dangan House **CH 69** Potential mass rock	-	**CH 1** Site of vernacular buildings **CH 3** Vernacular cottage **CH 5** Site of vernacular buildings **CH 6** Vernacular cottage **CH 27** Vernacular cottage **CH 31** Vernacular buildings **CH 48** Possible consumption wall **CH 64** Vernacular cottage

No indirect impacts during the operational phase on Areas of Archaeological Potential or Townland Boundaries have been identified.

13.5.5 Neutral/No Predicted Impacts

There are no predicted direct or indirect impacts for the following sites: AH 1, AH 3, AH 7, AH 9, AH 18, AH 19, AH 21, AH 22/ BH 23, AH 24, AH 30, AH 31, AH 36, AH 38, AH 39, AH 41/BH 21, AH 40, BH 22, BH 24, BH 25, BH 26, BH 27, DL 9, CH 43, CH 44, CH 46.

The potential impact has been deemed as neutral for the following sites: AH 4, AH 5, AH 6, AH 10, AH 13, AH 17, AH 20, AH 25, AH 28, AH 32, AH 33, AH 34, AH 35, AH 37.

BH 3, BH 4, BH 6, BH 8, BH 11, BH 13, BH 16, BH 18, BH 19, BH 20.

DL 1, DL 3, DL 5, DL 6.

CH 9, CH 11, CH 12, CH 14, CH 15, CH 16, CH 17, CH 28, CH 40, CH 41, CH 59, CH 63, CH 65, CH 66.

13.6 Mitigation Measures

13.6.1 Introduction

The proposed mitigation measures for the archaeological, architectural and cultural heritage are outlined below and detailed in **Appendix A.13.11**. A summary of all sites, structures, potential impacts and proposed mitigation is included in **Tables 13.21** to **13.26** in **Section 13.8**.

13.6.2 Construction Phase

The proposed mitigation measures for the construction phase are as follows:

- A programme of archaeological test trenching will be carried out within the footprint of the proposed road development prior to construction going ahead. This will target the sites and areas of archaeological and cultural heritage potential as outlined in **Section 13.5.3** as well as previously undisturbed areas within the proposed development boundary.
- Test trenching will be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be identified, if that is deemed the most appropriate manner in which to proceed.
- Prior to demolition, the thatched cottage BH 12 will be subject to a full measured, written and photographic survey. This will be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.

- Excavation of all previously recorded archaeological sites – where these fall, in whole or in part, within the footprint of the development – will be carried out under Ministerial Direction in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist
- The demesne landscape associated with Menlo Castle (DL 8), at Dangan Lower (DL7) and at Bushypark House (DL4) will be subject to a detailed photographic and written record prior to the construction of the proposed road development. This will be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.
- All Cultural Heritage (CH) sites listed in **Table 13.17** that include built heritage remains will be subject to a detailed written and photographic survey (to include test trenching where appropriate). This shall be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be identified, if that is deemed the most appropriate manner in which to proceed.
- Archaeological wade or underwater assessments will be carried out at any natural water courses (AAPs) to be impacted upon by the proposed road development by disturbance to their banks or beds. This shall be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be identified, if that is deemed the most appropriate manner in which to proceed.
- Any section of Townland Boundary to be impacted upon will be subject to a detailed written and photographic survey (to include test trenching where appropriate). This shall be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be identified, if that is deemed the most appropriate manner in which to proceed.

13.6.3 Operational Phase

The proposed mitigation measures for the operational phase are listed below. These measures are proposed to mitigate the indirect impacts of the operational phase of the proposed road development on these features. It is noted that these measures will be carried out during or prior to the construction phase.

- AH 15, 16, 29, 11, 12, 23 and 26 will be subject to a detailed photographic and written landscape record to preserve their current setting prior to the construction and operation of the proposed road development. This shall be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.

- BH 1, 7, 9, 10 and 17 will be subject to a detailed photographic and written landscape record to preserve their current setting prior to the construction and operation of the proposed road development. This shall be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.
- CH 20, 23, 8, 25, 30, 35, 42 and 54 will be subject to a detailed photographic and written landscape record to preserve their current setting prior to the construction of the proposed road development. This shall be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.

13.7 Residual Impacts

13.7.1 Introduction

13.7.2 Construction Phase

Once the recommended mitigation measures have been applied, there will be no residual impact on the archaeological, architectural or cultural heritage resource as a result of the construction of the proposed road development.

13.7.3 Operational Phase

Whilst the proposed mitigation measures will record the current context of those sites which will be indirectly impacted, they will not fully remove the residual impact of the proposed road development on the setting of the following sites:

- AH 15/ BH 19 Menlo Castle – post mitigation the operation of the proposed road development will have an indirect moderate negative impact on the castle
- AH 16/ BH 10 Summer House – post mitigation the operation of the proposed road development will have an indirect moderate negative impact on the castle

13.7.4 Cumulative Impacts

Cumulative impacts are defined as the combination of many minor impacts creating one, larger, more significant impact (NRA, 2009 and EPA 2017). Cumulative impacts consider existing stresses on the natural environment as well as developments that are underway and in planning.

The cumulative impacts of the proposed road development on archaeology, architecture and cultural heritage with the following projects and plans have been assessed:

- N59 Maam Cross to Oughterard Road Project
- M17 Galway to Tuam Road Project

- N18 Oranmore to Gort Road Project
- N17 Tuam Bypass
- M6 Motorway
- Proposed Galway Harbour Port Extension
- Galway Transport Strategy (GTS), which includes the following:
    - Investigate prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway
- Galway City Development Plan 2017 – 2023
- Galway County Development Plan 2015 – 2021

No proposed developments have been identified that will result in a significant negative cumulative impact with the addition the proposed road development upon the archaeological, architectural and cultural heritage resource.

The proposed Galway to Oughterard (part of the Galway to Clifden) Greenway will see the reopening of the railway line and potentially the repair of railway heritage features. The proposed road development will impact on a portion of the original railway line route where it passes through Dangan Lower. Sections of the railway line have been removed over the years due to differing activities, meaning that the proposed road development will result in a slight negative cumulative impact on the route of the original railway line. The proposed Galway to Oughterard Greenway scheme will have a positive impact on the cultural heritage of the area, which will help to offset the potential negative cumulative impact associated with the proposed road development. No negative residual impacts have been identified in association with the route of the former railway.

13.8 Summary

A summary of all sites, structures, potential impacts and proposed mitigation is included in **Tables 13.21** to **13.26** below.

One recorded monument (AH 2), which is listed as a Bullaun Stone will be profoundly and directly impacted upon as shown on **Figure 13.1.05**. However, it should be noted that the feature was not located during a field inspection and could not be previously located during a survey carried out by the Archaeological Survey of Ireland. The proposed road development will also have a moderate impact on the site of a quarry (AH 27). This site is post medieval in date and possesses little archaeological significance.

Ground disturbances associated with the proposed road development in general have the potential to have a moderate, significant or profound direct and negative impact on archaeological features, deposits or artefacts that have the potential to survive beneath the current ground surface with no surface expression.

One protected structure (BH 12) will be profoundly and directly impacted upon. This building, which consists of a single storey thatched structure, will be demolished (following a full architectural survey by suitably qualified staff) prior to the construction of the proposed road development.

The demesne landscape associated with Menlo Castle (DL 8) will be subject to a direct significant impact. The direct impact on the demesne landscape at Dangan Lower (DL 7) and at Bushypark House (DL 4) it is defined as moderate. Due to the developed nature of the environs at Rahoon House (DL 2) the impact, whilst direct, is imperceptible.

A total of 12 significant direct impacts on previously unrecorded sites or structures of cultural heritage significance were identified, along with nine moderate direct impacts.

A total of 12 Areas of Archaeological Potential have been identified during the course of this assessment. They are characterised by areas containing boggy ground and water courses, which are known to have attracted human activity in the past. Ground disturbances associated with the proposed road development have the potential to have a moderate, significant or profound direct and negative impact on archaeological features, deposits or artefacts that have the potential to survive beneath the current ground surface or water level within the designated AAPs.

A total of 33 Townland Boundaries will be crossed by the proposed road development. The impact upon these boundaries has been defined as direct and moderate in nature due to the relatively small percentage of a feature to be impacted upon.

As part of the proposed road development, an area of land within the townland of Menlough will be given over for the purpose of enhancing the habitat for bats – a population of which reside in the area, see **Chapter 8, Biodiversity** for further details. A number of sites outside of the receiving environment of the actual footprint of the proposed road development have been identified within this area, including Recorded Monuments and Protected Structures (AH 9, AH 22, AH 38-41, BH 21, BH 22-27). No predicted impacts are anticipated upon these sites as a result of the proposed habitat enhancement at Menlough.

A programme of archaeological testing, archaeological underwater or wade surveys, building surveys and townland boundary surveys have been recommended in order to mitigate the identified impacted during construction upon the archaeological, architectural and cultural heritage resource. All of the proposed surveys will be carried out by the appropriately qualified personnel under Ministerial Directions and in consultation with the Department of Culture, Heritage and Gaeltacht and a TII Project Archaeologist.

Predicted indirect operational impacts include significant negative impacts on the ruined summer house at Dangan Lower (AH 15/ BH 9) and Menlo Castle (AH 16/ BH 10). Moderate negative impacts are predicted at a recorded cashel site (AH 29/ BH 17). A thatched cottage (BH 1) and church (BH 7) will also be subject to indirect, moderate impacts.

The Designed Landscapes will all be subject to the same level of impacts during operation as during construction due to the impacts on setting. Similarly, two cultural heritage sites will experience significant indirect impacts and seven will experience moderate indirect impacts. No AAPs or Townland Boundaries will be indirectly impacted upon.

It should be noted that there are no predicted impacts at ten AH sites, one DL and three CH sites.

The impact has been deemed as neutral for 14 AH sites; ten BH sites; four DLs and 14 CH sites.

A programme of surveys has been recommended in order to record the current landscape context of sites and structures to be indirectly significantly or moderately impacted upon. These will be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.

Table 13.21: Archaeological Heritage (AH): Summary of sites, impacts and mitigation

AH No.	RMP No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	Statutory protection	Potential Impact type	Potential Impact level	Mitigation
AH 1	GA093-009	Na Foraí Maola Thiar	Redundant record: non-antiquity	0+500	9m east	None	No Impact	N/a	None required
AH 2	GA082-077	Rahoon	Bullaun Stone	6+850	0m	RMP	Direct	Profound negative	Archaeological testing in advance of construction
AH 3	GA082-040	Dangan Lower	Redundant record: non-antiquity	8+350	57m southeast	None	No Impact	N/a	None required
AH 4	GA094-047	Rahoon	House (Rahoon House) Also BH 18)	N59 Link Road South 3+350	153m southeast	RMP	Neutral	N/a	None required
AH 5	GA094-056	Rahoon	Designed Landscape Feature	Gort na Bró Road	61m southwest	RMP	Neutral	N/a	None required
AH 6	GA082-104	Bushypark	Enclosure	9+100	195m northwest	RMP	Neutral	N/a	None required
AH 7	GA082-032	Dangan Lower	Redundant record: non-antiquity	8+750	86m northeast	None	No Impact	N/a	None required
AH 8	GA082-039	Dangan Lower	Children’s Burial Ground	8+850	60m northeast	RMP	Indirect	Imperceptible negative	None required

AH No.	RMP No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	Statutory protection	Potential Impact type	Potential Impact level	Mitigation
AH 9	GA082-087	Mionlach	Settlement cluster	9+800	To the immediate north of proposed habitat enhancement for bats. 573m northwest of proposed road development.	None	No Impact	N/a	None required
AH 10	GA082-041	Dangan Lower	Well	8+650	173m east-southeast	None	Neutral	N/a	None required
AH 11	GA082-033	Dangan Lower	Barrow	8+700	198m southeast	RMP	Indirect	Slight negative	Written and photographic landscape record prior to construction
AH 12	GA082-036	Dangan Lower	Site of House (Dangan House)	9+150	90m northwest	RMP	Indirect	Slight negative	Written and photographic landscape record prior to construction
AH 13	GA082-085	Dangan Lower	Designed Landscape Feature	9+050	112m east-southeast	RMP	Neutral	N/a	None required
AH 14	GA082-038	Dangan Lower	Designed Landscape Feature	9+150	140m southeast	RMP	Indirect	Imperceptible negative	None required
AH 15	GA082-037	Dangan Lower	Summer house (Also BH 9)	9+300	72m southeast	RMP	Indirect	Significant negative	Written and photographic landscape record prior to construction

AH No.	RMP No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	Statutory protection	Potential Impact type	Potential Impact level	Mitigation
AH 16	GA082-064/001	Mionlach	House – 17th Century, Castle, unclassified (Also BH 10)	9+375	Adjacent to proposed habitat enhancement for bats. 140m northwest of proposed road development	RMP	Indirect	Significant negative	Written and photographic landscape record prior to construction
AH 17	GA082-100	Mionlach	Clearance cairn	9+500	Within proposed habitat enhancement for bats. 167m northwest of proposed road development	None	Neutral	N/a	None required
AH 18	GA082-031	Coolagh	Enclosure	11+350	0m	None	No Impact	N/a	None required
AH 19	GA082-095	Coolagh	Ringfort	11+400	0m	None	No Impact	N/a	None required
AH 20	GA082-003	Ballindooley	Quarry	12+025	81m north	RMP	Neutral	N/a	None required

AH No.	RMP No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	Statutory protection	Potential Impact type	Potential Impact level	Mitigation
AH 21	GA082-004	Ballindooley	Redundant record: non-antiquity	12+200	131m east-northeast	None	No Impact	N/a	None required
AH 22	GA082-060	Mionlach	Pillar stone (Also BH 23)	9+850	68m north of proposed habitat. 530m northwest of proposed road development.	RMP	No Impact	N/a	None required
AH 23	GA082-023	An Caisleán Gearr	Chapel (site of) (Also BH 14)	13+075	80m north	RMP	Indirect	Slight negative	Written and photographic landscape record prior to construction
AH 24	GA082-026	An Caisleán Gearr	Redundant record: non-antiquity	12+975	0m	None	No Impact	N/a	None required
AH 25	GA082-021	An Caisleán Gearr	Tower house (Also BH 13)	12+950	220m south	RMP	Neutral	N/a	None required
AH 26	GA082-022	An Caisleán Gearr	Children’s burial ground	13+500	73m southwest	RMP	Indirect	Slight negative	Written and photographic landscape record prior to construction
AH 27	GA082-072	Parkmore	Quarry	14+000	0m	None	Direct	Moderate negative	Archaeological testing in advance of construction
AH 28	GA082-016	Ballybrit	Anomalous stone group	14+850	124m southwest	RMP	Neutral	N/a	None required
AH 29	GA082-011/001-2	Ballybrit	Cashel, souterrain,	15+150	40m southwest	RMP	Indirect	Moderate negative	Written and photographic landscape record prior to construction

AH No.	RMP No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	Statutory protection	Potential Impact type	Potential Impact level	Mitigation
			children's burial ground (Also BH 17)						
AH 30	GA082-017	Ballybrit	Earthwork	City East Business Park Junction.	0m	RMP	No Impact	N/a	None required
AH 31	GA082-015	Ballybrit	Designed landscape feature	City East Business Park Junction.	57m south	None	No Impact	N/a	None required
AH 32	GA082-012002	Ballybrit	Deserted medieval settlement	14+500	226m northeast of the City East Business Park Junction	RMP/ Preservation Order	Neutral	N/a	None required
AH 33	GA082-012001	Ballybrit	Tower house (Also BH 16)	14+500	250m northeast of the City East Business Park Junction	RMP/ Preservation Order	Neutral	N/a	None required
AH 34	GA082-014	Ballybrit	Enclosure	15+050	110m northeast of the City East	RMP/ Preservation Order	Neutral	N/a	None required

AH No.	RMP No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	Statutory protection	Potential Impact type	Potential Impact level	Mitigation
					Business Park Junction				
AH 35	GA082-013/ 001	Ballybrit	Ringfort & house (unknown date)	15+050	165m northeast of the City East Business Park Junction	RMP/ Preservation Order	Neutral	N/a	None required
AH 36	GA082-043/ 001-4	Doughiska	Fulachta fia	16+400	0m	RMP	No Impact	N/a	None required
AH 37	GA082-044	Doughiska	Road	16+350	43m west southwest	RMP	Neutral	N/a	None required
AH 38	GA082-063	Mionlach	Designed landscape feature	9+550	Adjacent to proposed habitat enhancement for bats. 448m northwest of proposed road development.	None	No Impact	N/a	None required
AH 39	GA082-062	Mionlach	Designed landscape feature	9+650	Within proposed habitat	None	No Impact	N/a	None required

AH No.	RMP No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	Statutory protection	Potential Impact type	Potential Impact level	Mitigation
					enhancement for bats. 448m northwest of proposed road development.				
AH 40	GA082-061	Mionlach	Burial ground	9+600	Adjacent to proposed habitat enhancement for bats. 577m northwest of proposed road development.	RMP	No Impact	N/a	None required
AH 41	GA082-070	Mionlach	Gate house (Also BH 21)	9+750	50m east of proposed habitat enhancement for bats. 406m northwest of proposed road development.	RMP	No Impact	N/a	None required

Table 13.22: Built Heritage (BH): Summary of sites, impacts and mitigation

BH No.	RPS No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	NIAH	Statutory protection	Impact type	Potential Impact level	Mitigation
BH 1	6302	Mincloon	Thatched cottage	6+150	53m northwest	No	Yes	Indirect	Moderate negative	Written and photographic landscape record prior to construction
BH 2	6301	Mincloon	Thatched cottage	6+400	183m southeast	No	Yes	Indirect	Slight negative	Written and photographic landscape record prior to construction
BH 3[35]	2001	Barnacranny	Gate pillars	8+450	Adjacent	No	Yes	Neutral	N/a	None required
BH 4	2901	Barnacranny	Thatched cottage	8+450	6m southwest	Yes	Yes	Neutral	N/a	None required
BH 5	1504	Kentfield	Bushypark House	N59 Link Road North 0+000	60m northeast	Yes	Yes	Indirect	Slight negative	Written and photographic landscape record prior to construction

[35] No evidence of gate pillars at this location

BH No.	RPS No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	NIAH	Statutory protection	Impact type	Potential Impact level	Mitigation
BH 6	1503	Ballagh	Thatched Cottage	N59 Link Road North 0+050	124m northwest	No	Yes	Neutral	N/a	None required
BH 7	1501/02	Ballagh	Church	N59 Link Road North 0+060	20m southeast	Yes	Yes	Indirect	Moderate negative	Written and photographic landscape record prior to construction
BH 8[36]	3003	Ballagh	Remains of stone fort	8+950	184m east-northeast	No	Yes	Neutral	N/a	None required
BH 9	3001	Dangan Lower	Summer house (Also AH 15)	9+300	72m southeast	No	Yes	Indirect	Significant negative	Written and photographic landscape record prior to construction
BH 10	5702	Mionlach	Menlo Castle (Also AH 16)	9+350	140m northwest of proposed road development	Yes	Yes	Indirect	Significant negative	Written and photographic landscape record prior to construction

[36] No evidence of this site type at this location

BH No.	RPS No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	NIAH	Statutory protection	Impact type	Potential Impact level	Mitigation
BH 11	2402	Coolagh	Thatched cottage	10+750	63m northwest of the proposed development at Lackagh Quarry	No	Yes	Neutral	N/a	None required
BH 12	1703	An Caisleán Gearr	Thatched cottage	12+875	0m	Yes	Yes	Direct	Profound negative6	Full measured survey, written and photographic record prior to construction
BH 13	1701	An Caisleán Gearr	Tower House (Also AH 25)	12+950	220m south	No	Yes	Neutral	N/a	None required
BH 14	1702	An Caisleán Gearr	Chapel, site of (Also AH 23)	13+100	80m north	No	Yes	Indirect	Slight negative	Written and photographic landscape record prior to construction
BH 15	7601	Parkmore	Two ruined cottages	13+800	99m southwest	No	Yes	Indirect	Imperceptible negative	None required
BH 16	701	Ballybrit	Tower House (Also AH 33)	14+500	250m northeast of the City East Business	No	Yes	Neutral	N/a	None required

BH No.	RPS No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	NIAH	Statutory protection	Impact type	Potential Impact level	Mitigation
					Park Junction					
BH 17	702	Ballybrit	Cashel (Also AH 29)	15+150	40m southwest	No	Yes	Indirect	Moderate negative	Written and photographic landscape record prior to construction
BH 18	8301	Rahoon	Rahoon House (Also AH 4)	N59 Link Road South 3+350	153m southeast	No	Yes	Neutral	N/a	None required
BH 19	8301	Rahoon	Entrance to Rahoon House	N59 Link Road South 3+300	188m southeast	Yes	Yes	Neutral	N/a	None required
BH 20	1705	An Caisleán Gearr	Free standing stone cross	13+450	162m southwest	No	Yes	Neutral	N/a	None required
BH 21	5703	Mionlach	Gate house (Also AH 41)	9+750	406m northwest of proposed road development. 50m east of area	Yes	Yes	No Impact	N/a	None required

BH No.	RPS No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	NIAH	Statutory protection	Impact type	Potential Impact level	Mitigation
					proposed for habitat planting.					
BH 22	5710	Mionlach	Thatched cottage	9+800	522m northwest of proposed road development. 53m north of area proposed for habitat planting.	Yes	Yes	No Impact	N/a	None required
BH 23	5704	Mionlach	Pillar stone (Also AH 22)	9+850	530m northwest of proposed road development. 68m north of area proposed for habitat planting.	No	Yes	No Impact	N/a	None required
BH 24	5709	Mionlach	Thatched cottage	9+850	586m northwest of proposed road development.	Yes	Yes	No Impact	N/a	None required

BH No.	RPS No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	NIAH	Statutory protection	Impact type	Potential Impact level	Mitigation
					97m north of area proposed for habitat planting.					
BH 25	5708	Mionlach	Thatched cottage	9+000	596m northwest of proposed road development. 163m north of area proposed for habitat planting.	Yes	Yes	No Impact	N/a	None required
BH 26	5707	Mionlach	Thatched cottage	9+950	645m northwest of proposed road development. 191m north of area proposed for habitat planting.	Yes	Yes	No Impact	N/a	None required
BH 27	5711	Mionlach	Thatched cottage	9+950	319m northwest of proposed	Yes	Yes	No Impact	N/a	None required

BH No.	RPS No.	Townland	Classification	Approx. Ch.	Dist. from proposed road development	NIAH	Statutory protection	Impact type	Potential Impact level	Mitigation
					road development. 200m northeast of area proposed for habitat planting.					

Table 13.23: Designed Landscapes (DL): Summary of sites, impacts and mitigation

DL No.	Townland:	Detail:	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
DL 1	Bearna, Cluain na nGabhar, Gort na Leice, An Roisín, An Seanbhaile Dubh, Baile an Mhóinín Thoir	Barna House demesne. NIAH garden survey lists it as 'Main features unrecognisable – peripheral features visible'[37]. Barna House is a protected structure.	The northwest corner of the demesne is located c. 143m to the southeast	Neutral	N/a	None required
DL 2	Rahoon	Rahoon House demesne. NIAH garden survey lists it as 'Virtually no recognisable features'[38]. The main house is a protected structure (BH 18).	Proposed link road will run through the northwest corner of the original demesne	Direct	Imperceptible negative	None required
DL 3	Kentfield	Glenlo Abbey demesne. The NIAH garden survey records it as 'Main features unrecognisable – peripheral features visible'[39]. The main house is not a protected structure.	The southeast corner of the demesne is located to the immediate north of the proposed road development where it extends along the N59 Moycullen Road	Neutral	N/a	None required

[37] NIAH Garden Ref.: GA-45-M-248237
[38] NIAH Garden Ref.: GA-45-M-273253
[39] NIAH Garden Ref.: GA-45-M-267283

DL No.	Townland:	Detail:	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
DL 4	Bushypark	Bushypark House demesne. The NIAH garden survey lists it as 'Main features substantially present – peripheral features unrecognisable'[40]. The principal structure is still extant (BH 5) and is listed as a protected structure.	The proposed link road will terminate to the immediate southwest of the demesne and associated drainage infrastructure will extent through the eastern portion of the demesne	Direct	Moderate negative	Written and photographic landscape record prior to construction
DL 5	Barnacranny	Lake View House demesne. Not included within the NIAH garden survey. The house is still extant today (CH 39).	The north-eastern side of the demesne is located to the immediate south of the proposed road development where it extends along the N59 Moycullen Road	Neutral	N/a	None required
DL 6	Dangan Upper	Ashley Park demesne. The NIAH garden survey records it as 'possessing virtually no recognisable features'[41]. The principal structure remains extant today (CH 40)	The north-eastern side of the demesne is located to the immediate south of the proposed road development where it extends along the N59 Moycullen Road.	Neutral	N/a	None required
DL 7	Dangan Lower	Dangan Cottage, Dangan House, Dangan Nunnery, Mary Ville demesnes.	The proposed road development travels in a north-east direction	Direct	Moderate negative	Written and photographic landscape record prior to construction

[40] NIAH Garden Ref.: GA-45-M-272278
[41] NIAH Garden Ref.: GA-45-M-283271

DL No.	Townland:	Detail:	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
		The NIAH garden survey only includes an entry for Dangan House (which actually refers to Dangan Cottage). It reports 'virtually no recognisable features remain'[42].	through the original demesne lands.			
DL 8	Mionlach	Menlo Castle Demesne. NIAH garden survey records it as 'Main features unrecognisable – peripheral features visible'[43]. Today the principal structure survives in ruins on the site (BH 10). The principal structure and its entrance are both protected structures.	The proposed road development travels in a north-east direction through the original demesne lands. The western part of the original demesne is located within an area of proposed for habitat enhancement.	Direct	Significant negative	Written and photographic landscape record prior to construction
DL 9	Ballybrit	Ballybrit House demesne. The NIAH garden survey lists the area as possessing 'virtually no recognisable features'[44].	A short section of proposed existing infrastructure upgrade in located in the northeast corner of the original demesne landscape location.	No impact	N/a	None required

[42] NIAH Garden Ref.: GA-45-M-284274
[43] NIAH Garden Ref.: GA-45-M-284278
[44] NIAH Garden Ref.: GA-46-M-333272

Table 13.24: Cultural Heritage (CH): Summary of sites, impacts and mitigation

CH No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
CH 1	Na Foraí Maola Thiar	Site of vernacular structures. No longer extant.	0+150	15m west	Indirect	Imperceptible negative	None required
CH 2	Na Foraí Maola Thiar	Site of vernacular structures. No longer extant.	0+130	0m	Direct	Significant negative	Archaeological testing prior to construction
CH 3	Na Foraí Maola Thiar	Single storey vernacular cottage.	0+175	145m east	Indirect	Imperceptible negative	None required
CH 4	Na Foraí Maola Thiar	Sub-circular stone enclosure (Also AH 1 redundant record).	0+500	7m east	Indirect	Moderate negative	Written and photographic landscape record prior to construction
CH 5	Na Foraí Maola Thiar	Site of ruined vernacular structures.	0+450	72m east	Indirect	Imperceptible negative	None required
CH 6	Troscaigh Thiar	Single storey vernacular cottage.	1+550	77m north-northwest	Indirect	Imperceptible negative	None required
CH 7	Na Foraí Maola Thoir	Single storey vernacular cottage.	1+500	10m south	Indirect	Slight negative	Written and photographic landscape record prior to construction
CH 8	Troscaigh Thiar	Walled laneway.	1+950	0m	Direct	Moderate negative	Written and photographic record prior to construction
CH 9	Troscaigh Thiar	Possible famine bridge.	1+650	119m northeast	Neutral	N/a	None required.

CH No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
CH 10	Troscaigh Thiar	Site of a post medieval sheep fold. No longer extant.	2+110	0m	Direct	Moderate negative	Archaeological testing prior to construction
CH 11	Troscaigh Thiar	Single storey vernacular cottage.	2+250	17m west	Neutral	N/a	None required.
CH 12	Troscaigh Thiar	Ruins of a vernacular building.	2+150	140m west	Neutral	N/a	None required.
CH 13	Troscaigh Thoir	Vernacular cottage and associated farm buildings.	2+400	33m south			
CH 14	An Chloch Scoilte	Vernacular cottage.	2+700	102m northwest	Neutral	N/a	None required.
CH 15	An Chloch Scoilte	Ruins of a vernacular cottage.	2+800	210m north	Neutral	N/a	None required.
CH 16	An Chloch Scoilte	The ruinous remains of the post medieval settlement of An Chloch Scoilte.	2+900	191m north	Neutral	N/a	None required.
CH 17	Troscaigh Thoir	Vernacular cottage, now extended.	3+075	146m south-southeast	Neutral	N/a	None required.
CH 18	An Chloch Scoilte	Vernacular cottage, now extended.	3+260	0m	Direct	Significant negative	Written and photographic record prior to construction
CH 19	An Cheapach	Vernacular cottage and associated farm building.	4+350	116m north-northwest	Indirect	Slight negative	Written and photographic landscape record prior to construction

CH No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
CH 20	An Cheapach	Vernacular cottage and outbuildings.	4+340	10m south	Indirect	Significant negative	Written and photographic record prior to construction
CH 21	An Cheapach	Site of vernacular structures. No longer appears to be extant.	4+520	14m north	Indirect	Slight negative	Written and photographic landscape record prior to construction
CH 22	An Cheapach	Group of ruined vernacular structures.	4+450	20m east	Indirect	Slight negative	Written and photographic landscape record prior to construction
CH 23	An Cheapach	Vernacular cottage. Now derelict.	4+600	6m southeast	Indirect	Significant negative	Written and photographic record prior to construction
CH 24	Ballynahown East	Ruins of a vernacular cottage.	4+900	35m southeast	Indirect	Slight negative	Written and photographic landscape record prior to construction
CH 25	Keeraun	Vernacular farm yard.	5+500	24m northwest	Indirect	Moderate negative	Written and photographic landscape record prior to construction
CH 26	Keeraun	Vernacular cottage, now derelict.	5+650	0m	Direct	Significant negative	Written and photographic record prior to construction
CH 27	Keeraun	Vernacular cottage.	5+700	23m west-northwest	Indirect	Imperceptible negative	None required
CH 28	Keeraun	Vernacular cottage.	5+900	217m north-northeast	Neutral	N/a	None required.

CH No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
CH 29	Mincloon	Site of vernacular structures. No longer extant.	6+300	0m	Direct	Significant negative	Archaeological testing prior to construction
CH 30	Mincloon	Vernacular house and farmstead.	6+450	13m west	Indirect	Moderate negative	Written and photographic landscape record prior to construction
CH 31	Mincloon	A number of vernacular outbuildings.	6+500	75m east-southeast	Indirect	Imperceptible negative	None required
CH 32	Mincloon	A stone outbuilding.	6+500	0m	Direct	Moderate negative	Written and photographic record prior to construction
CH 33	Rahoon	Stone-walled laneway.	6+975	0m	Direct	Moderate negative	Written and photographic record prior to construction
CH 34	Rahoon	Site of vernacular structures marked. No longer extant.	7+280	0m	Direct	Significant negative	Archaeological testing prior to construction
CH 35	Rahoon	Leitriff House.	7+350	88m southeast	Indirect	Moderate negative	Written and photographic landscape record prior to construction
CH 36	Letteragh	Stone-walled laneway.	7+410	0m	Direct	Moderate negative	Written and photographic record prior to construction

CH No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
CH 37	Dangan Upper	Well-built cairns from stone clearance.	7+600	0m	Direct	Moderate negative	Written and photographic record prior to construction
CH 38	Ballagh	Possible square enclosure.	N59 Link Road North 0+150	0m	Direct	Significant negative	Archaeological testing prior to construction
CH 39	Barnacranny	Lake View House.	8+350	39m southeast	Indirect	Slight negative	Written and photographic landscape record prior to construction
CH 40	Dangan Upper	Ashley Park.	8+700	19m southeast	Neutral	N/a	None required.
CH 41	Dangan Lower	Mary Ville.	8+950	15m east	Neutral	N/a	None required.
CH 42	Dangan Lower	Ruined stone outbuilding.	8+725	8m southeast	Indirect	Moderate negative	Written and photographic landscape record prior to construction
CH 43	Dangan Lower	Site of Dangan Cottage.	8+800	27m southeast	No impact	N/a	None required.
CH 44	Dagan Lower	Site of walled garden and outbuildings associated with Dangan House (Nunnery).	9+100	38m northwest	No impact	N/a	None required.
CH 45	Mionlach	Possible boating inlet off the River Corrib.	9+450	33m southeast	Indirect	Slight negative	Written and photographic landscape record prior to construction

CH No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
CH 46	Mionlach	Possible circular enclosure identified during AP analysis.	9+600	28m southeast of alignment (within proposed habitat enhancement for bats)	No impact	N/a	None required.
CH 47	Mionlach	Possible vernacular animal shelter.	9+700	34m northwest	Indirect	Slight negative	Written and photographic landscape record prior to construction
CH 48	Mionlach	Possible consumption wall.	9+600	24m northeast	Indirect	Imperceptible negative	None required
CH 49	Mionlach	Possible prehistoric tomb.	9+850	0m	Direct	Significant negative	Archaeological testing prior to construction
CH 50	Mionlach	Possible circular feature.	10+375	56m south	Indirect	Slight negative	Written and photographic landscape record prior to construction
CH 51	Mionlach	Possible boulder of archaeological potential.	10+500	0m	Direct	Moderate negative	Archaeological testing prior to construction
CH 52	Mionlach	Site of vernacular structures. No longer appear to be extant.	10+600	0m	Direct	Significant negative	Archaeological testing prior to construction
CH 53	An Caisleán Gearr	Ruins of a vernacular structures.	13+225	97m south-southeast	Indirect	Slight negative	Written and photographic landscape record prior to construction

CH No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
CH 54	An Caisleán Gearr	Vernacular cottage.	13+775	39m north	Indirect	Moderate negative	Written and photographic landscape record prior to construction
CH 55	Parkmore	Site of vernacular structures marked. No longer extant.	13+925	0m	Direct	Significant negative	Archaeological testing prior to construction
CH 56	Parkmore	Site of vernacular structures. No longer extant.	14+120	0m	Direct	Significant negative	Archaeological testing prior to construction
CH 57	Parkmore	Possible mass path.	14+200	0m	Direct	Significant negative	Archaeological testing & written and photographic record prior to construction
CH 58	Coolagh	Site of vernacular structures. No longer extant.	15+850	0m	Direct	Significant negative	Archaeological testing prior to construction
CH 59	Breanloughaun	Vernacular outbuilding.	15+800	150m east-northeast	Neutral	N/a	None required.
CH 60	Coolagh	Two storey vernacular farm house.	16+400	169m northeast	Indirect	Slight negative	Written and photographic landscape record prior to construction
CH 61	Coolagh	Renovated vernacular cottage and outbuilding.	16+550	260m northeast	Indirect	Slight negative	Written and photographic landscape record prior to construction

CH No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
CH 62	Coolagh	Group of vernacular buildings. The structures are all upstanding but vary in condition.	16+625	188m northwest	Indirect	Slight negative	Written and photographic landscape record prior to construction
CH 63	Bushypark	Ruins of a vernacular structure.	N59 Link Road North 0+000	3m northeast	Neutral	N/a	None required.
CH 64	Letteragh	Vernacular cottage, now extended.	N59 Link Road South 1+575	113m southeast	Indirect	Imperceptible negative	None required
CH 65	Letteragh	Ruins of a vernacular cottage.	N59 Link Road South 1+600	229m east-southeast	Neutral	N/a	None required.
CH 66	Rahoon	Vernacular house, recently renovated.	N59 Link Road South 2+050	159m west-northwest	Neutral	N/a	None required.
CH 67	Dangan Lower	Dangan House.	9+100	199m southeast	Indirect	Slight negative	Written and photographic landscape record prior to construction
CH 68	Bushypark	Disused railway	Pipeline wayleave	0m	Direct	Moderate negative	Written and photographic record prior to construction
CH 69	Bushypark	Potential mass rock	Pipeline wayleave	30m west-northwest	Indirect	Slight negative	Written and photographic landscape record prior to construction
CH 70	Bushpark/ Dangan Lower	Railway culvert	Pipeline wayleave	To the immediate east	Direct	Moderate negative	Written and photographic record prior to construction

CH No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
CH 71	Mincloon	Walled trackway	6+200	0m	Direct	Moderate negative	Written and photographic record prior to construction
CH 72	Mionlach	Walled trackway	9+800	0m	Direct	Moderate negative	Written and photographic record prior to construction

Table 13.25: Areas of Archaeological Potential (AAP): Summary of sites, impacts and mitigation

AAP No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
AAP 1	Na Foraí Maola Thiar/ Cnoc na Gréine	Liberty Stream (TB 2)	0+430 -0+650	0m	Direct	Moderate-profound negative	Underwater archaeological assessment prior to construction
AAP 2	Troscaigh Thoir/ An Chloch Scoilte	Trusky Stream (TB 6)	2+650 -2+950	0m	Direct	Moderate-profound negative	Underwater archaeological assessment prior to construction
AAP 3	Na hAille/ An Cheapach	Barna Stream (TB 10)	3+850 -4+150	0m	Direct	Moderate-profound negative	Underwater archaeological assessment prior to construction
AAP 4	Ballynahown East	Stream (TB 12)	4+800 -5+200	0m	Direct	Moderate-profound negative	Underwater archaeological assessment prior to construction

AAP No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
AAP 5	Rahoon	Stream and boggy hollow	6+800 -6+900	0m	Direct	Moderate-profound negative	Underwater archaeological assessment & archaeological testing prior to construction.
AAP 6	Rahoon	Small stream	7+300 – 7+375	0m	Direct	Moderate-profound negative	Underwater archaeological assessment prior to construction
AAP 7	Barnacranny	Small stream	7+500 -7+675	0m	Direct	Moderate-profound negative	Underwater archaeological assessment prior to construction
AAP 8	Barnacranny	Boggy, waterlogged marginal lands	N59 Link Road North 0+500 to 0+850	0m	Direct	Moderate-profound negative	Archaeological testing prior to construction
AAP 9	Dangan Lower/ Mionlach	River Corrib (TB 22)	9+175-9+525	0m	Direct	Moderate-profound negative	Underwater archaeological assessment prior to construction
AAP 10	An Caisleán Gearr	Boggy pasture – margins of *Lough an Dúlaigh*	12+200 - 12+450	0m	Direct	Moderate-profound negative	Archaeological testing prior to construction
AAP 11	An Caisleán Gearr	Boggy hollow (AH 24)	12+975 – 13+075	0m	Direct	Moderate-profound negative	Archaeological testing prior to construction.

AAP No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
AAP 12	Bushypark	Site of 'Loughaunnafraska'	Pipeline wayleave	0m	Direct	Moderate-profound negative	Archaeological testing prior to construction

Table 13.26: Townland Boundaries (TB): Summary of sites, impacts and mitigation

TB No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
TB 1	An Baile Nua/ Na Foraí Maola Thiar	Sea Road (R336)	0+000	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 2	Na Foraí Maola Thiar/ Cnoc na Gréine	Liberty Stream (Also AAP 1)	0+450 – 0+650	0m	Direct	Moderate negative	Written and photographic record & underwater archaeological assessment prior to construction
TB 3	Na Foraí Maola Thiar/ Na Foraí Maola Thoir	Local Road	1+100	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 4	Na Foraí Maola Thoir/ Troscaigh Thiar	Local Road	1+550	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 5	Troscaigh Thiar/ Troscaigh Thoir	Hedgerow & modern fence	2+425	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 6	Troscaigh Thoir/ An Chloch Scoilte	Former site of townland boundary	2+650 - 2+850	0m	Direct	Moderate negative	Written and photographic record, underwater archaeological assessment

TB No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
		including a portion of stream (AAP 2)					and archaeological testing prior to construction
TB 7	Troscaigh Thoir/ An Chloch Scoilte/ Ballard West	Stone wall	2+975 - 3+200	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 8	Ballard West/ Ballard East/ An Chloch Scoilte	Local road. Boundary between Ballard West and East not extant	3+250 - 3+350	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 9	Ballard East/ Na hAille	Stone wall	3+490	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 10	Na hAille/ An Cheapach	Barna Stream (AAP 3)	4+100	0m	Direct	Moderate negative	Written and photographic record & underwater archaeological assessment prior to construction
TB 11	An Cheapach/ Ballynahown East	Stone walled laneway	4+700 – 4+800	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 12	Ballynahown East/ Keeraun	Stream (AAP 4) and field boundary (boundary completely overgrown)	4+800-5+250	0m	Direct	Moderate negative	Written and photographic record & underwater archaeological assessment prior to construction
TB 13	Keeraun/ Ballyburke	Stone wall and hedgerow	5+660 - 5+725	0m	Direct	Moderate negative	Written and photographic record prior to construction

TB No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
TB 14	Ballyburke/ Mincloon	Stone wall	6+050	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 15	Mincloon/ Rahoon	Stone wall	6+800	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 16	Rahoon/ Letteragh	Stone wall, sections of which have been removed	7+400	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 17	Letteragh /Barnacranny	Stone wall	7+550	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 18	Barnacranny/ Dangan Upper	Stone wall	7+740	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 19	Barnacranny/ Dangan Upper	No access granted	8+200	0m	Direct	Moderate negative	Written and photographic record/ archaeological testing, prior to construction
TB 20	Dangan Upper/ Dangan Lower/ Kentfield/ Ballagh/ Bushypark	N59 Moycullen Road (crossed at 2 points)	8+525	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 21	Barnacranny/ Ballagh	Stone wall and ditch	N59 Link Road North 0+550	0m	Direct	Moderate negative	Written and photographic record & archaeological testing prior to construction
TB 22	Dangan Lower/ Menlough	River Corrib (AAP 9)	9+350	0m	Direct	Moderate negative	Underwater archaeological assessment

TB No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
							& written and photographic record prior to construction
TB 23	Mionlach/ Ballindooley	Stone wall	10+725	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 24	Coolagh/ Ballindooley/ An Caisleán Gearr	Quarried away	11+600	0m	No impact	N/a	None required
TB 25	Ballindooley/ An Caisleán Gearr	Stone wall and hedgerow	11+600 - 12+250	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 26	An Caisleán Gearr/ Parkmore	Tuam Road	13+900	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 27	An Caisleán Gearr/ Cappanabornia	Hedgerow	13+840	0m	Direct	Moderate negative	Written and photographic record & archaeological testing prior to construction
TB 28	Cappanabornia/ Parkmore	Tuam Road	13+840	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 29	Parkmore/ Pollkeen	Stone wall	14+350	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 30	Parkmore/ Ballybrit	Removed	14+750	0m	Direct	Moderate negative	Archaeological testing prior to construction
TB 31	Ballybrit/ Doughiska	Removed	15+600	0m	Direct	Moderate negative	Archaeological testing prior to construction

TB No.	Townland	Description	Approx. Ch.	Dist. from proposed road development	Impact type	Potential Impact level	Mitigation
TB 32	Doughiska/ Coolagh/ Breanloughaun	Stone wall and road	15+750-16+800	0m	Direct	Moderate negative	Written and photographic record prior to construction
TB 33	Rahoon/ Letteragh	Stone wall	N59 Link Road South 1+620	0m	Direct	Moderate negative	Written and photographic record prior to construction

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14 Material Assets – Agriculture

14.1 Introduction

This chapter of the EIAR consists of an appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, under the heading of material assets - agriculture.

This chapter initially sets out the methodology followed (**Section 14.2**), describes the receiving environment (**Section 14.3**), and summarises the main characteristics of the proposed road development which are of relevance for material assets – agriculture (**Section 14.4**). The evaluation of impacts of the proposed road development on material assets-agriculture are described (**Section 14.5**). Measures are proposed to mitigate these impacts (**Section 14.6**) and residual impacts are described (**Section 14.7**). The chapter concludes with a summary (**Section 14.8**) and reference section (**Section 14.9**).

This chapter has utilised the information gathered during the previous phases of the proposed road development to inform the material assets-agriculture impact appraisal. **Sections 4.12**, **6.5.7** and **7.6.7** of the **Route Selection Report** considered the material assets agriculture constraints within the scheme study area and compared the potential material assets - agriculture impacts of the proposed route options respectively. These sections of the Route Selection Report contributed to the design of the proposed road development which this chapter appraises.

14.2 Methodology

14.2.1 Introduction

This chapter is prepared having regard to the standard guidelines for environmental assessment published by the EPA in 2002, 2003 and draft guidelines published in 2015 and 2017 and also uses the guidelines for arriving at significance of impact as discussed in the UK Highway Agency Design Manual for Roads and Bridges. The information sources referred to in **Section 14.2.3** below are standard for agricultural impact assessment for new road developments.

14.2.2 Guidelines

The following guidelines were referred to while preparing and writing this chapter:

- EPA (Environmental Protection Agency): Guidelines on the information to be contained in environmental impact assessment reports, (Draft May 2017)
- EPA: Revised Guidelines on the Information to be contained in Environmental Impact Statements, (2002 and Draft, September 2015)
- EPA: Advice Notes For Preparing Environmental Impact Statements, (2003 and Draft, September 2015)

14.2.3 Data Sources and Consultations

The information sources which support this impact appraisal are described in **Table 14.1** below.

Table 14.1: Data sources used for the Agricultural Assessment

Information	Data Source
Agricultural statistics	• Census of Agriculture 2010[1] from the Central Statistics Office (CSO) – used to provide background data on the average size and enterprise mix of farms in County Galway • CSO, Average crop yields from 2008 – 2016 and Teagasc data for grass production at Ballyhaise Agricultural College (2008 – 2016)
Soils	• EPA digital soils data • The 'General Soil Map of Ireland' (1980) • Windshield survey, orthophotography, and on-farm surveys
Land use & farm details	• Land registry mapping data • Farmer interviews • Windshield survey • Orthophotography - used as an aid in examining farm layout and land quality

A consultation letter was sent to the Department of Agriculture, Food and the Marine November 2016.

14.2.3.1 Technical Limitations

The author was able to engage directly with landowners in relation to 145 land parcels[2] (74%) of a total of 195 agricultural land holdings directly affected by the proposed road development. Where landowners could not be contacted directly the following information sources used were:

- Roadside vantage point surveys
- Examination of aerial photography
- Reference to other desk information sources such as Land Registry Mapping, CSO statistics for County Galway and Digital Soil Data

The available data was sufficient for the agricultural impact appraisal along the entire proposed road development.

[1] The Census of Agriculture 2010 is the most up to date survey providing data on farm and enterprise types and size on a per County basis.
[2] Where landowners could not be contacted directly the agricultural consultant wrote to the landowner.

14.2.4 Study Area and Baseline Data Collection

The study area comprises of 195 agricultural land parcels that are directly affected by the proposed road development, a total area of approximately 1,096 hectares. The locations of these land parcels is shown in **Figures 14.1.1** to **14.1.14** and extends from Na Foraí Maola in the west of the study area to Coolagh in the east. Proximity to an expanding city has resulted in many smaller, fragmented holdings and this combined with poor land quality (particularly west of the Corrib) means that the sensitivity of agriculture along the proposed road development is low (48% of land parcels are low or very low sensitivity). Landowner interviews and on-site surveys were conducted by the author in January 2016 – December 2017. Where possible landowners were interviewed and asked to describe their farming enterprise, how the land is being used, how access is provided and to identify sensitive features on their farms such as farm yards, wells/springs and access tracks and gates.

14.2.5 Impact Assessment Methodology

The assessment of agricultural impacts involves:

1. Evaluation of the baseline environment, the types of farms and the sensitivity of the individual farms along the route of the proposed road development
2. Evaluation of the nature and magnitude of the effects on each farm and the effects on farming collectively along the entire route of the proposed road development and within County Galway
3. Having considered the sensitivity of the baseline agricultural environment and the magnitude of effects, the impact significance is predicted for:
    a. each land parcel affected along the route of the proposed road development
    b. agriculture collectively along the proposed road development (i.e. locally within the study area)
    c. agriculture within County Galway (i.e. regionally)

These three elements of the methodology are described in **Sections 14.2.6.1**, **14.2.6.2** and **14.2.6.3**. It is important to note that this agricultural appraisal assesses the changes that will occur to the physical agricultural environment and assumes that, because landowners are compensated for attributable financial losses, their financial status will not change.

14.2.5.1 Evaluation of sensitivity of farms

Each land parcel is evaluated to determine its sensitivity based mainly on the criteria shown in **Table 14.2** below.

Table 14.2: Criteria for categorisation of sensitivity of farms

Farm Enterprise Type	Sensitivity
Stud farm, Equestrian centre	High - Very High
Dairy farm, Intensive equine enterprises	High
Non-dairy grazing livestock enterprises (including beef, sheep and non-intensive equine) and grass cropping enterprise	Medium
Tillage	Medium
Rough Grazing, Bog, Forestry, Woodland (where poor land quality restricts farming practices)	Low - Very low

Each appraisal of sensitivity is subject to professional judgement and evaluation of other site specific factors such as the land quality and importance of the enterprise.

14.2.5.2 Evaluation of impact magnitude

The magnitude of the potential impact is assessed by predicting the change on the affected farm or on agriculture along the route of the proposed road development. For example, if the proposed road development takes 10% of an affected grassland farm, and provided the farm enterprise can continue after the proposed road development is constructed, it is possible to predict that the yield of grass from the farm will be affected by approximately 10%. In order to quantify the magnitude of the impact, typical baseline trends[3] in the agricultural environment are examined and interpreted using the author's professional judgement. Therefore, impacts which result in a 2.5% to 5% variation in yield are considered to create a low magnitude impact on the farm and are similar to natural baseline trends in yield and is considered low magnitude. Between 5% and 10% the magnitude of yield loss is starting to exceed the natural baseline trends and is considered medium. Yield effects which exceed 10% are considered to be high magnitude. Other factors affect the magnitude of impact such as, severance or separation of land, the duration of impact, the quality of land affected and impact on farm yards and other facilities on the farm. **Table 14.3** shows the criteria which are used to indicate the magnitude of impact and each assessment is subjected to professional judgement.

[3] According to CSO data (2008 – 2016) the yield of spring barley and winter wheat will vary by approximately 7.5% from the average mean yield. Similarly, according to Teagasc data for grass production at Ballyhaise Agricultural College (2008 – 2016), the natural trend is for grass production to vary on average by 8% from year to year.

Table 14.3: Indicative criteria for assessment of impact magnitude

Indicative Criteria	Impact Magnitude
• A high proportion of the land permanently taken (e.g. >10%) • A high proportion of farm permanently separated (e.g. > 15 %) • Farm buildings or water sources may be affected permanently	High – Very High
• A medium proportion of the farm permanently taken (e.g. 5% - 10%) • A medium proportion of farm permanently separated (e.g. 7 % - 15%) • Farm buildings or water sources may be affected but can be replaced • Temporary (construction) impacts which have long term effects	Medium
• A small proportion of the farm permanently taken (e.g. 2.5% - 5%) • A small proportion of farm separated or no separation (e.g. 2.5% - 7%) • Farm buildings or water sources generally not affected but if affected can be replaced • Temporary (construction) impacts which have short – medium term effects	Low
• A very small proportion of the farm taken (e.g. <2.5%) • A very small proportion of farm separated or no separation (e.g. <2.5% of the farm) • Temporary (construction) impacts which do not have residual effects	Negligible – Very Low

Impacts that occur during the construction phase will generally have low or very low magnitude because of the short duration (e.g. construction noise and vibration). Medium magnitude impacts may arise during construction where for example there is a long term impact on land drainage as a result of the construction activity.

14.2.5.3 Evaluation of significance of impact

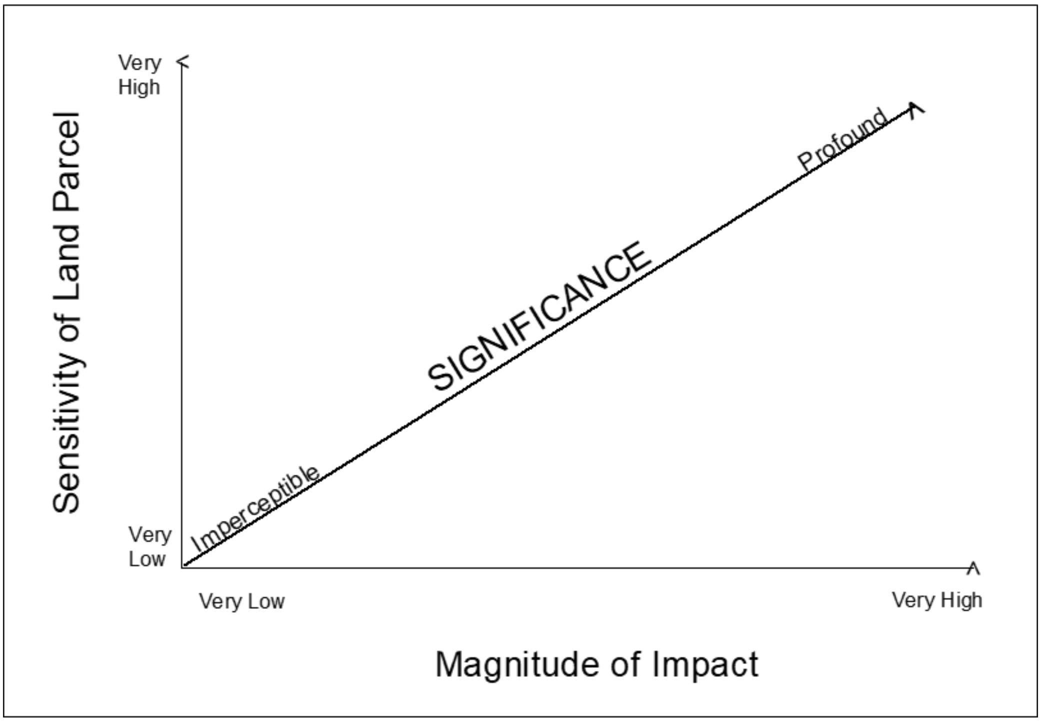
The significance of the impact is determined by evaluating both the magnitude of the impact and the sensitivity of the affected farm. Therefore, an impact which affects a farm with a low sensitivity will not be as significant as a similar magnitude of impact which affects a farm with a high sensitivity.

Section 3.7.3 of the EPA Guidelines on the information to be contained in environmental impact assessment reports (Draft, May 2017) contains guidelines for describing the significance of impacts. These guidelines have been adopted with minor adjustments that are appropriate for agricultural impact assessment. In general the impacts on agriculture are adverse in nature. The comparisons between the EPA guidelines and the criteria used in this appraisal are shown in **Table 14.4**.

Table 14.4: Comparison of significance of impact criteria used in this assessment with the EPA 2015 Guidance

Significance of impacts as per EPA 2017 Guidance	Significance of impacts used in this appraisal
Imperceptible Impact An effect capable of measurement but without significant consequences	**Not Significant Impact** An impact which may result in measurable effects and / or noticeable changes but the consequences are not significant.
Not Significant An effect which causes noticeable changes in the character of the environment without significant consequences	
Slight Impact An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.	**Slight Adverse Impact** An impact which causes noticeable changes in the character and management of a farm in a minor way. The farm enterprise experiences inconvenience as a result of the proposed road development.
Moderate Impact An effect that alters the character of the environment in a manner that is consistent with existing emerging trends.	**Moderate Adverse Impact** An impact which alters the character of a farm in a manner that requires moderate changes in the management and operation of the farm. The farm enterprise can be continued as before but with increased management or operational difficulties.
Significant Impact An effect which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.	**Significant and Very Significant Adverse Impact** An impact which by its character, magnitude, duration or intensity alters a sensitive aspect of the farm. The farm enterprise can be continued, but will require major changes in management and operation of the farm. This would typically occur where the farm was split in two due to separation but where access between the separated portions and the farm buildings could still be achieved effectively. Assuming the enterprise can continue the degree of change in the management and operation of the farm will determine whether the impact is Significant or Very Significant.
Very Significant Impact An effect which by its character, magnitude, duration or intensity alters the majority of a sensitive aspect of the environment.	
Profound Impact An effect which obliterates sensitive characteristics.	**Profound Adverse Impact** An impact which obliterates sensitive characteristics of the farm. The farm enterprise cannot be continued as a result of the proposed road development. This would occur where landtake was of such a scale that the remaining land would not form a viable unit or where separation was of such a nature to make the holding unworkable or where important farm buildings and facilities were removed and could not be replaced. In some situations, the farm enterprise may continue but will require dramatic changes in the future management and operation of the farm, such that the scale and operation of the enterprise is changed dramatically.

Plate 14.1: Significance of Impact on Land Parcel Impacts



Significance of impact is determined by evaluating the magnitude of impacts and sensitivity of the farm. This assessment is subject to variation due to professional judgement on a case by case basis.

14.3 Receiving Environment

14.3.1 Agricultural Enterprise Types

195 land parcels are directly affected by the proposed road development. The locations of these land parcels are shown on **Figures 14.1.1** to **14.1.14**. **Table 14.5** below compares land use along the route of the proposed road development to the statistics for County Galway. The Census of Agricultural (2010) Statistics categorises land use into eight agricultural groups: specialist tillage, specialist dairy, specialist beef, specialist sheep, mixed grazing livestock, mixed crops and livestock, mixed field crops (mainly hay & silage) and other. For this appraisal the number of groups is reduced to five for comparison purposes as follows:

- Mainly Dairy - entirely a dairy farm or the dairy enterprise is the most significant target of the impact). Generally high sensitivity
- Non-dairy grazing livestock and mixed field crops– includes specialist beef cattle, specialist sheep, and mixed farms with cattle, sheep and horses. Generally medium sensitivity
- Mainly tillage - tillage cropping. Generally medium sensitivity
- Mixed crops and livestock - various crops and livestock. Medium sensitivity
- Other (e.g. pigs, poultry, horticultural cropping and equine as the main enterprises). Medium – very high sensitivity

The Census of Agriculture 2010 statistics show that the average size of farms in County Galway is 25.8 hectares. This compares to a national average size of 32.7 hectares. The average size of land parcels along the route of the proposed road development is approximately 6.0 hectares. The small size of land parcels along the proposed road development is a result of the close proximity to Galway City. Many holdings have been subdivided among family members and land has been sold for development. Approximately 21% of land parcels are less than 1 hectare in size and therefore have limited agricultural use. Beef farming is the main enterprise along the route of the proposed road development. Compared to the national average the number of small equine enterprises along the proposed road development is high; these horses are mainly kept for leisure purposes.

Table 14.5: Land Use Statistics along the Proposed Road Development compared to National and Regional Statistics

Farm/Enterprise Category	Total Nos. of affected land parcels within each category	% of farms within each category		
		Land parcels along proposed road development	Farms in Co. Galway	Farms nationally
Mainly Dairy	6	3	3	11
Beef and/or sheep and hay/silage	123 (4 with sheep)	63	95	82.5
Mainly Tillage	0	0	0.5	3.5
Mixed Crops & Livestock	0	0	1	2
Other (Equine)	34 (31 equine)	17.5	0.5	1
Not Farmed	32	16.5	0	0
Total	195	100	100	**100**

Table 14.5 shows that the main farm enterprise along the route of the proposed road development is beef (and sheep). The sensitivity of these land parcels range from very low to medium. There is one high sensitivity beef enterprise (cattle trader – PRO[4] 701) and two high[5] sensitivity dairy enterprises (PRO 239 & PRO 241). The Galway Racecourse (MO[6] 691) is classified as very high sensitivity due to the equine enterprise and regional importance. There are two very high sensitivity equine land parcels (MO 751 & MO 760) and the remaining equine enterprises are medium, low or very low sensitivity enterprises where horses and donkeys are kept mainly for leisure purposes. See **Appendix 14.1** for details of each individual land parcel.

[4] Protected Road Scheme Reference Number
[5] There are six dairy land parcels. Two dairy farmers rent four adjoining land parcels which are classified as medium sensitivity.
[6] Motorway Scheme Reference Number

14.3.2 Soil Types

Soil types along the route of proposed road development are described in detail in **Chapter 9, Soils and Geology** of this EIAR. In general, the soil quality is poorer west of the River Corrib. From the townland of An Baile Nua to Na hAille the dominant soil type is a peaty soil with rock out crops and interspersed with blanket bog. The drainage is poor and the land is wet. From Na hAille to the River Corrib the dominant soil type is a poorly drained mineral soil. East of the River Corrib the quality of land improves from an agricultural perspective; although the quality is variable. Adjoining the River Corrib there is low lying alluvium soils that are subject to flooding. Further east in Menlough and Ballindooley the topography is undulating and the dominant soil type is a mineral brown earth interspersed with a shallow soil with limestone out crop. From Ballindooley to Doughiska the dominant soil is a shallow free draining mineral soil. The topography is flat or gently undulating. This land is good quality grazing land and some of it is suitable for tillage. In general the soil types along the route of the proposed road development are suited to non-intensive grazing by beef cattle.

14.4 Characteristics of the Proposed Development

A detailed description of the proposed road development and construction activities are provided in **Chapter 5, Description of Proposed Road Development** and **Chapter 7, Construction Activities**. This section outlines the characteristics and activities of the proposed road development of relevance to material assets - agriculture.

The proposed road development will consist of a road carriageway, embankments, cut slopes, accommodation works, drainage features and planted/landscaped areas which will traverse agricultural lands. Approximately 219 hectares of land will be acquired from affected land parcels for the proposed road development.

14.4.1 Construction Phase

It is estimated that the construction period will last for approximately 36 months. At the beginning of the construction phase the land to be acquired will be fenced and access across it is restricted. In certain situations, temporary crossing points for livestock and machinery will be allowed until accommodation roads are constructed. Water and power supplies will be disrupted requiring alternative sources and ducting under the proposed road development. Watercourses will be diverted and the carriageway will be lower and higher than the adjoining farm land at different locations. This will disrupt land drainage requiring the construction of culverts and maintenance of the land drainage along the edge of the earthworks for the proposed road development.

Construction of the proposed road development will require activities such as excavation, tunnel work, pilling, rock breaking/blasting and movement of materials within the fenced off works area (ref. **Chapter 7, Construction Activities**). This will generate noise, dust and movement of machinery which will potentially impact on adjoining lands (ref. **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration**). The duration of these works will vary. In the worst case scenario (for example beside an in-situ crushing plant) this disturbance could last the entire construction period for that location, however, in general it is expected that construction activities such as rock breaking/blasting at any one location will last for a period of few days up to a few weeks.

14.4.2 Operational Phase

When the construction phase is complete and the mitigation measures implemented the residual effects of the proposed road development will be permanent. These effects will result in a change in the structure and layout of farms along the route of the proposed road development reducing the size and separating part of farms. A low level of disturbance will be experienced due to traffic. Landowners will be compensated to ensure they are not at a financial loss.

14.5 Evaluation of Impacts

14.5.1 Introduction

The potential impacts on each land parcel along the route of the proposed road development are evaluated and a summary presented in **Tables 14.6** and **14.7**. An assessment of the potential impacts on agriculture along the entire route (i.e. within the study area) is presented in **Sections 14.5.3** and **14.5.4**. The potential cumulative and regional impacts on agriculture are addressed in **Sections 14.5.5** and **14.5.6**.

14.5.2 Do Nothing Impact

Farmers as members of the local community regularly use the existing road network to access schools and shops and to purchase goods and sell produce. Tractors travel on the existing road network to access farms and herds of cattle. Lorries and goods vehicles deliver and collect goods from farms. In the “Do Nothing” scenario the existing traffic congestion will continue to have a small adverse impact on agriculture which is considered to be not significant.

14.5.3 Potential Construction Impacts

General construction noise and vibration and the generation of dust will have no significant or slight adverse impacts. Rock breaking/blasting and piling activities may result in a flight response in livestock but rarely causes a significant impact, particularly with mitigation, and will have no significant or slight adverse impacts. The landtake will result in the acquisition of farm buildings (mostly small sheds and outhouses) on 17 land parcels[7], which will result in temporary impacts because these facilities can be replaced with new buildings on the retained lands. There will be temporary disruption to power and water supplies but with mitigation the impact is not significant or slight adverse. Land drainage will be affected during the construction period where drainage outfalls from agricultural land is intercepted or blocked by the proposed road development. The proposed drainage design insures

[7] Ref Nos PRO/MO 117, 154, 229, 243, 259, 289, 495, 498, 572, 583, 625, 626, 632, 691, 689, 701 & 754

that all drainage outfalls are maintained or redirected to a suitable outfall and with mitigation the impacts are generally not significant.

Once the proposed development boundary fencing is erected the land inside it is no longer available to the landowner. The reduction in land area is a permanent impact and the range of impact due to loss of land ranges from not significant to profound. The proposed road development will cross 62 land parcels causing separation of part of the farm, separating approximately 163 hectares of land and creating 87 new land parcels. During construction temporary crossing points for livestock and machinery will be allowed until accommodation roads are constructed. Land separation is a permanent impact and the range of impact is not significant to significant adverse.

14.5.4 Potential Operational Impacts

The mitigation measures set out in **Section 14.6** will be constructed and implemented during the construction phase. Maintenance of the proposed road development will continue during the operational phase and in a very small number of cases remedial works may have to be carried out during the operational phase (e.g. maintenance of the fenceline along the mainline of the proposed road development). The land loss impact which commences with the fencing off of the acquired land during the construction period is a permanent residual impact that continues in the operational phase. The reduction in size will result in a reduction in farm output and the range of impact is not significant to profound. This impact cannot be mitigated except through compensation. In the longer term landowners may be able to replace the area of acquired land, but generally the replacement land will be separated from the original holding. Similarly, the separation of parts of farms (often referred to a severance) is a permanent impact that can be mitigated by providing access roads to the separated land parcel. This will result in additional travel distances and additional fixed costs on a farm and the range of impact is not significant to significant adverse. Impacts on drainage are generally not significant or slight adverse. The permanent disturbance impact caused by traffic, noise, air emissions and lighting is not significant.

14.5.5 Summary of Potential Impacts

The potential (pre-mitigation) impacts on land parcels along the route of the proposed road development are summarised in **Table 14.6**.

Table 14.6: Summary of Potential (Pre-Mitigation) Impacts

	Numbers of Land parcels				
Significance of Impact	**Mainly Dairy**	**Beef / sheep and hay / silage**	**Other (incl. Equine)**	**Not farmed**	**Totals**
Not significant	2	33	8	16	**59**
Slight	1	22	6	8	**37**
Moderate	-	19	6	6	**31**
Significant	-	35	11	2	**48**

	Numbers of Land parcels				
Significance of Impact	**Mainly Dairy**	**Beef / sheep and hay / silage**	**Other (incl. Equine)**	**Not farmed**	**Totals**
Very Significant	1	6	0	-	**7**
Profound	2	8	3	-	**13**
Total Nos. of Farms	**6**	**123**	**34**	**32**	**195**
	68 land parcels are predicted to have impacts which are significant adverse and greater (35% of all affected land parcels)				

The agricultural study area consists of 195 land parcels and 1,096 hectares of land of which approximately 219 hectares is within the proposed development boundary. Before mitigation, the potential impact on the study area is moderate adverse where in addition to 219 hectares of agricultural land which is acquired an additional, 172 hectares of land is separated without effective access (16% of the total agricultural area).

14.6 Mitigation Measures

14.6.1 Introduction

Mitigation of potential impacts takes place under two headings:

- General mitigation measures – described in **Sections 14.6.2 Construction Phase** and **14.6.3 Operational Phase** below
- Compensation under the Compulsory Purchase System – compensation to farmers for residual damage is part of the statutory process for compensation

14.6.2 Construction Phase

1. The landowner will be provided with access to all separated land parcels during the construction of the proposed road development. Where temporary disruptions to this access occur landowners will be notified in advance.
2. Where existing water and electricity supplies are disrupted during the construction phase an alternative water source or electricity supply will be made available e.g. water tanker or electric cable ducting. If access to surface drinking water sources are permanently restricted alternative groundwater supplies will be provided (or compensation to allow farmer drill his own well).
3. Suitable boundary fencing will be erected to delineate the line of the proposed development boundary and prevent disturbance to adjacent land.
4. A key contact person will be appointed during the construction phase to facilitate communications between affected landowners and to facilitate the re-organisation of farm enterprises by farmers during critical times.
5. Landowners with lands adjoining sites where either rock breaking, blasting or piling takes place will be notified in advance of these activities.

6. The impacts on water quality will be minimised by way of a programme of mitigation measures for surface and ground water sources as described in **Chapters 10, Hydrogeology** and **Chapter 11, Hydrology**.
7. The spread of dust onto adjoining lands will be minimised by way of mitigation measures set out in **Chapter 16, Air Quality and Climate**. Typically, the impact of dust on agricultural grazing livestock is not significant.
8. Where drainage outfalls are temporarily altered or land drains blocked or damaged an adequate drainage outfall will be maintained and land drains will be repaired.

14.6.3 Operational Phase

1. The loss of agricultural land due to the construction of the proposed road development is a permanent loss which cannot be mitigated except through financial compensation.
2. Landowners who lose buildings to the proposed road development will be compensated. Compensation payments will enable farmers to replace buildings.
3. All separated land parcels will be accessible either via the local road network, via accommodation access roads and access tracks.
4. Where existing water and electricity supplies to fields or farm yards are severed, the supply will be reinstated by provision of ducting where possible. Alternatively, where ducting is not feasible a permanent alternative water source or electricity supply will be made available. Compensation payments will enable farmers to replace power and water supplies.
5. Landowners may have to build additional farm facilities (e.g. cattle holding and testing pens) on their separated land. Field boundaries and paddock systems may have to be re-organised to take into account the altered shape of fields. These matters are addressed in the compensation settlements.
6. Water from the proposed road development will be diverted to attenuation ponds before discharging to watercourses or to ground. The drainage design of the proposed road development will intersect existing field drains and carry the drainage water to suitable outfalls.
7. Other injury impacts such as loss of shelter, removal of field boundaries, disruption of farm roads and field paddock systems and the increased potential for trespass on to private land due to the proposed road development are taken into account in this assessment. Statutory compensation will be used to compensate landowners for residual effects and to allow the landowners to execute mitigation measures and re-instatement works on their own land.
8. Landscaping along the proposed road development will minimise the visual impact on farms along the route of the proposed road development and will over time improve shelter in affected farms.

14.7 Residual Impacts

14.7.1 Introduction

Residual impacts are evaluated for each of the farms affected by the proposed road development. The impact on agriculture along the route of the proposed road development and within County Galway is evaluated and cumulative impacts are considered.

14.7.2 Construction Phase

The impacts resulting from the generation of noise, dust and construction traffic are temporary in nature and with mitigation are not significant. Prior to the construction of access roads or access tracks land will be separated by the proposed road development. In such situations points of temporary access will be provided to landowners to allow them to access their separated land parcels during the construction phase. Disturbance due to construction activity will be temporary and the impact is expected to be not significant or slight adverse. Land drainage impacts that are mitigated during the construction phase are not significant.

14.7.3 Operational Phase

The operational phase is considered to be in excess of 30 years and therefore residual effects that occur for this duration are permanent and therefore more significant than the temporary impacts that occur during the 36-month construction phase. Impacts such as loss of land and separation (severance) of land occur during the construction phase but are permanent residual impacts in the operational phase also. The design of the proposed road development will ensure that the land drainage of affected farms is not significantly affected and the significance of impact is not significant or slight adverse. The residual impacts on farms along the route of the proposed road development is summarised in **Table 14.7**.

Table 14.7: Summary of Residual Impacts

	Numbers of Land parcels				
Significance of Impact	**Mainly Dairy**	**Beef / sheep and hay / silage**	**Other (incl. Equine)**	**Not farmed**	**Totals**
Not significant	2	33	9	15	**59**
Slight	1	28	6	9	**44**
Moderate		25	8	8	**41**
Significant	1	28	10		**38**
Very Significant		8	0		**9**
Profound	2	1	1		**4**
Total Nos. of Land parcels	**6**	**123**	**34**	**32**	**195**
51 land parcels are predicted to have an impact which is significant adverse or greater (26% of all affected land parcels)					

The agricultural study area along the proposed road development consists of the area of all land parcels directly affected i.e. approximately 1,096 hectares. Approximately 219 hectares of land will be acquired which is approximately 20% of the study area. Land separation will affect 62 land parcels and 172 hectares of land will be separated – approximately 16% of the affected area. However, after mitigation effective access will be provided to the separated lands. The overall residual impact on agriculture along the proposed road development (i.e. within the study area) is moderately adverse.

14.7.4 Cumulative Impacts

The cumulative impact on regional agriculture is appraised by assessing the impact on agriculture in County Galway due to the landtake for the proposed road development in combination with other recently constructed and planned roads (M6, N17 / N18, N59 Maam Cross to Oughterard and Moycullen Bypass). The planned M6 (M17/M18) Motorway Service Area and the GTS measures (Eastern Galway City Park & Ride, Bearna Greenway, Galway to Oughterard Greenway and Galway City to Oranmore Cycleway) are also considered. These recently constructed and planned projects in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends[8] the cumulative impact on agriculture in County Galway is not significant.

There are cumulative impacts from the recently constructed M6 Scheme on four individual land parcels at the eastern end of the proposed road development. While there are significant cumulative impacts individually on these four[9] land parcels

[8] From 2010 – 2016 cattle numbers and sheep numbers increased 7% and 25% respectively – source CSO Table AAA08 and DAFM website.
[9] MO 751, MO 752, MO 754, and MO 758.

within the study area, the overall cumulative impacts on agriculture is not significant.

14.8 Summary

The proposed road development will traverse an area mainly consisting of small agricultural holdings. The land quality west of the River Corrib is generally poor and although mixed, the quality of land is better east of the River Corrib. The main farming enterprise is beef cattle. There is a relatively high proportion of very low – medium sensitivity equine enterprises along the route of the proposed road development.

The proposed road development will acquire approximately 219 hectares of land from 195 land parcels and will create separated land on 62 land parcels, resulting in the following residual impacts:

- 103 not significant and slight adverse (53% of land parcels along the route of the proposed road development)
- 41 moderate adverse (21% of land parcels along the route of the proposed road development)
- 38 significant adverse (19% of land parcels along the route of the proposed road development)
- 9 very significant adverse (5% of land parcels along the route of the proposed road development)
- 4 profound impacts (2.0% of land parcels along the route of the proposed road development)

The impact on agriculture within the study area is moderate adverse when cumulative effects from land loss due to other road developments are considered. The impact at a regional level (i.e. County Galway) is not significant.

14.9 References

CSO. (2010) *Census of Agriculture 2010 from the Central Statistics Office (CSO)*.

CSO. *Average crop yields from 2008 – 2015*.

Teagasc data for grass production at Ballyhaise Agricultural College (2008 – 2014).

EPA. (Environmental Protection Agency). (2002 and Draft, September 2015) *Revised Guidelines on the Information to be contained in Environmental Impact Statements*.

EPA. (2003 and Draft, September 2015) *Advice Notes For Preparing Environmental Impact Statements*.

EPA. (Draft, May 2017) *Guidelines on the information to be contained in environmental impact assessment reports*.

Arriving at Level of Significance – Table 2.1, Volume 2, part 5 of Design Manual for Roads and Bridges.

Electronic Sources

Teagasc. (2016) *Data and Downloads* [online] Available at: http://gis.teagasc.ie/soils/downloads.php

15 Material Assets – Non-Agriculture

15.1 Introduction

This chapter of the EIAR consists of an appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, under the heading of material assets non-agriculture.

This chapter initially sets out the methodology followed (**Section 15.2**), describes the receiving environment (**Section 15.3**) and summarises the main characteristics of the proposed road development which are of relevance for material assets – non agriculture (**Section 15.4**). The evaluation of impacts of the proposed road development on material assets non-agriculture are described (**Section 15.5**), measures are proposed to mitigate these impacts (**Section 15.6**) and residual impacts are described (**Section 15.7**). The chapter concludes with a summary (**Section 15.8**) and reference section (**Section 15.9**).

This chapter has utilised the information gathered during the constraints and route selections studies for proposed road development to inform the material assets non-agriculture impact appraisal. **Sections 4.13**, **6.5.8** and **7.6.8** of the **Route Selection Report** considered the material assets non-agriculture constraints within the scheme study area and compared the potential of material assets non-agriculture impacts of the proposed route options respectively. These assessments and sections of the Route Selection Report contributed to the design of the proposed road development.

Material Assets are defined in the EPA Advice notes on current practice in the preparation of EIS (EPA 2003) as “resources that are valued and that are intrinsic to specific places, they may be either human or natural origin and the value may arise for either economic or cultural reasons”. The EPA revised Advice notes (2015) state that the “assessment shall be concerned primarily with ensuring equitable and sustainable use of resources”. Material assets of natural origin include renewable and non-renewable resources and assimilative capacities of such resources. Material assets of human origin include cultural heritage, cities/towns/settlements, transportation infrastructure, utilities/services infrastructure, land use, ownership and access, agronomy, property and tourism/recreational infrastructure. The EPA Guidelines on information to be contained in Environmental Impact Assessment Reports (2017), state that “Material assets can now be taken to mean built services and infrastructure” and includes roads and traffic and waste management.

Material assets are appraised in a number of chapters of this EIA Report as follows:

Natural resources are examined in **Chapter 9, Soils and Geology**, **Chapter 10, Hydrogeology** and **Chapter 11, Hydrology**. Cultural heritage is examined in **Chapter 13, Archaeological, Architectural and Cultural Heritage** whilst cities, towns, communities and settlements are examined in **Chapters 18, Human Beings, Population and Human Health** and **Chapter 2, Planning and Policy**. Tourism is also examined in **Chapter 18, Human Beings, Population and Human Health**. Agricultural assets (agronomy) are examined in **Chapter 14, Material Assets –**

Agriculture. The appraisal of waste management and associated infrastructure and proposed road closures are presented in **Chapter 7, Construction Activities**. The proposed road development and the associated traffic is presented in **Chapter 5, Description of Proposed Road Development** and **Chapter 6, Traffic Assessment and Route Cross Section**.

This chapter addresses the following aspects:

- Land use and ownership (non-agricultural properties including residential, commercial and industrial properties)
- Utilities (such as power, water supply, gas, sewerage, telecommunications)
- Land use zonings and planning permissions

15.2 Methodology

15.2.1 Introduction

This assessment is based on a desk study and on information gathered during consultations with landowners, utility and service providers and members of the public. The desk study included an inspection of land registry records, examination of aerial photography and inspection of planning records. A number of site walkovers and site visits with landowners and utility providers were also conducted to inform the findings of this assessment, see **Table 15.1** for further details.

15.2.2 Guidelines

This chapter is prepared in accordance with the following guidance documents:

- Environmental Protection Agency (EPA) - Advice Notes on Current Practice (2003)
- EPA - Guidelines on the Information to be contained in Environmental Impact Statements (2002)
- National Roads Authority (NRA) - Environmental Impact Assessment of National Road Schemes – A Practical Guide (2008)
- Environmental Protection Agency (EPA) Draft Revised Guidelines on Information to be contained in Environmental Impact Statements (EPA, 2015)
- Environmental Protection Agency (EPA) Draft Advice Notes for Preparing Environmental Impact Statements (EPA, 2015)
- Environmental Protection Agency (EPA) Draft Guidelines on Information to be contained in Environmental Impact Assessment Reports (EPA, 2017)

15.2.3 Data Sources and Consultations

The sources of the information gathered for this assessment are listed in **Table 15.1** below.

Table 15. 1: Sources of Data

Information	Data Sources
Landowner and land use details	Over 950 meetings with landowners have taken place since May 2014 A project office was set up in Ballybrit, Galway and facilitated ease of access for landowners and it became the central data collection point Public consultations in July 2014, January / February 2015 and May 2015 Public display November / December 2016 Design Update letters October 2016 and May 2017 Land registry to identify ownership of land and location of boundaries Aerial photography Galway City Development Plan 2017 – 2023 Galway County Development Plan 2015 – 2021 Bearn Local Area Plan 2007 – 2017 Gaeltacht Local Area Plan 2008 – 2018 (Amended 25 March 2013) Ardaun LAP 2018 – 2024 National University of Ireland, Galway, Strategic Plan 2015 – 2020
Location of properties	Windshield surveys Site visits to landowner properties Aerial photography Ordnance Survey (OS) Mapping
Planning applications	Galway County Council planning files Galway City Council planning files
Service Providers	Galway County Council – Water Services Department for Drainage and Roads and Transportation Department for Traffic Galway City Council – Water Services Department for Drainage and Roads and Transportation Department for Traffic Irish Water – Watermain, Foul Sewer Industrial Development Authority Ireland (IDA) Éir Electricity Supply Board (ESB) (ESB Networks) Electricity Supply Board International (ESBI) Eirgrid Gas Networks Ireland – Transmission and Distribution E-Net SSE Airtricity Virgin Media BT Ireland Three Networks Ireland Vodafone

15.2.4 Study area and Baseline Data Collection

The extents of the study area defined for the material assets non-agriculture assessment is the lands within the proposed development boundary, i.e. all lands to be acquired for the proposed road development and extends from An Baile Nua west of Bearna Village to Coolagh, Briarhill in the east. There are 313 non-agricultural properties including dwellings, industrial and commercial properties, NUIG Sporting Campus, Galway Racecourse and zoned lands that are directly affected by the proposed road development. A total area of 184 hectares including agricultural land zoned for future development but excluding agricultural lands which are not zoned, will be included within the proposed development boundary. The location of these land holdings is shown in **Figures 14.1.1** to **14.1.15**. All of the utilities within the proposed development boundary are also included in this assessment. The baseline data was collected from the sources outlined in **Table 15.1**.

15.2.5 Impact Assessment Methodology

Ten types of property were examined in the material assets non-agriculture assessment:

- Residential property
- Commercial property
- Industrial property
- Community property
- Amenity / Recreational areas – large wooded areas, sporting facilities, parks
- NUIG Sporting Campus
- Public Facilities – Churches, Community Centre etc.
- Lands zoned for residential, commercial or industrial development
- Other non-agricultural property
- Planning permissions for any of the above which have been granted

The potential impact on the infrastructure of public and private utilities / service providers and water supply is also assessed.

The potential impact of the proposed road development on non-agricultural properties and other material assets, listed above, was determined based on the following:

- Acquisition[1] or demolition[2] of buildings / facilities (including developments with live granted planning permission)

[1] Acquisition of a material asset results in the local authority being the property owner; it may be resold at a future time for reuse.
[2] Demolition of a material asset results in that property being razed to the ground and it is not available for reuse in its current form.

- Size of holding
- Size of land to be acquired
- Proximity of the landtake to the residence / business
- Loss of access
- Continued viability of the property / material asset

The level of impact of the proposed road development on non-agricultural properties is assessed according to the significance criteria detailed below in **Table 15.2**. These criteria were based on the EPA guidance documents listed above in **Section 15.2.2**. Each property is assessed on a case by case basis.

Table 15.2: Criteria for Assessing the Significance of Impact on Material Assets

Significance Level / Degree of Impact	Definition
Profound	An impact which obliterates sensitive characteristics. Occurs where a non-agricultural property or other material asset of national or regional importance is acquired and/or demolished
Very Significant	An impact which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment. Occurs where part, or all, of a non-agricultural property or other material asset is acquired, which may result in demolition of the property or removal of more than one asset in the area, e.g. a cluster of properties in one area are proposed to be demolished or impact to a substantial community asset, or where acquisition results in loss of employment and total loss of the business
Significant	An impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment. Occurs where part, or all, of a non-agricultural property or other material asset is acquired, which may result in demolition of the property or removal of the asset, e.g. a single dwelling in one area is proposed to be demolished or removal of a business, or where acquisition results in partial loss of the business or total loss of the business without loss of employment
Moderate	An impact that alters the character of the environment in a manner which is consistent with existing and emerging baseline trends. Occurs where part, or all, of a non-agricultural property or other material asset is acquired, resulting in a major change to the environment of the property or material asset, e.g. the full acquisition of a property or a large portion of landtake from the property or the diversion of high voltage ESB network (110kV or 38kV) or gasman, or where acquisition results in partial loss of the business or potential business
Slight	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities. Occurs where part of a non-agricultural property or other material asset is acquired, resulting in little change to the environment, e.g. a small portion of landtake from a property
Not significant	An impact which causes noticeable changes in the character of the environment but without noticeable consequences, e.g. the removal of a boundary wall or entrance to a property or the diversion of low and medium voltage ESB network, telecommunications or water supply and foul sewer services
Imperceptible	An impact capable of measurement but without noticeable consequences. Occurs where part of a non-agricultural property or other material asset is acquired, resulting in minimal changes to the environment of the property or

Significance Level / Degree of Impact	Definition
	material asset. This includes impacts on properties which are currently occupied by a public right-of-way. These lands are in the ownership of the adjacent property, however are occupied by existing roads.

15.3 Receiving Environment

The land along the proposed road development is a mixture of agricultural land (see **Chapter 14, Material Assets - Agriculture**) and non-agricultural lands which consist of residential clusters, villages, industrial and commercial properties as shown on **Figures 14.1.1** to **14.1.15** and described in the following sections. These figures show a plan of each landowners known holding from which lands will be acquired. The extents of the lands that are proposed to be acquired for the purposes of the proposed road development will be set out in the Protected Road Scheme[3] and Motorway Scheme Deposit Maps.

15.3.1 Material Assets Non-Agriculture excluding Services

15.3.1.1 R336 to Ballymoneen Road – Ch. 0+000 to Ch. 5+600

The proposed road development commences on the R336 in An Baile Nua approximately 2km west of Bearna Village and then proceeds north and east to the north of Bearna Village and onwards towards Letteragh passing through the townlands of Na Foraí Maola Thiar, Na Foraí Maola Thoir, Troscaigh Thiar, Troscaigh Thoir, Ballard West, Ballard East, and An Chloch Scoilte, An Cheapach and Ballymoneen.

This area is predominantly agricultural with sporadic one off rural housing and one commercial property within the area. The building pattern of existing homes is ribbon development like along the rural roads. There is planning for a dwelling in Na Foraí Maola Thiar. There is a crèche located on the Cappagh Road to the north of the proposed road development (see also **Chapter 18, Human Beings, Population and Health**).

The density of housing increases east of Cappagh Road as the proposed road development proceeds east towards Ballymoneen Road. There is a large residential development to the south east of the proposed road development on Ballymoneen Road in Ballyburke and an existing planning permission for a large residential development within this townland.

[3] A protected road, means a public road or proposed public road specified to be a protected road in a protected road scheme approved by An Bord Pleanála. A protected road scheme approved by An Bord Pleanála may provide for the prohibition, closure, stopping up, removal, alteration, diversion or restriction of any specified or all means of direct access to the protected road from specified land or from specified land used for a specified purpose or to such land from the protected road.

15.3.1.2 Ballymoneen Road to River Corrib – Ch. 5+600 to Ch. 9+300

Proceeding east through the townlands of Ballyburke, Rahoon, Mincloon and Letteragh toward Letteragh Road the lands to the north of the proposed road development are agricultural compared to the residential lands to the south. The lands between Ch. 5+850 and Ch. 6+060 are zoned as residential. There are also a number of residential zoned lands along the Rahoon Road and Letteragh Road. There is one valid planning permission for housing to the south of the proposed road development along Ballymoneen Road. Gateway Retail Park and Galway West Business Park are located at the southern end of Rahoon Road (see also **Chapter 18, Human Beings, Population and Health**). There is a fully granted planning permission for a primary school within the lands to the south of the Rahoon Road, however this is outside of the proposed development boundary.

As the proposed road development proceeds east through the townlands of Barnacranny, Bushypark and Dangan towards the River Corrib it enters a more urban and residential area. St. James' National School, Bushypark is located immediately to the south of the proposed road development but outside the proposed development boundary. Glenlo Abbey Hotel and Golf Course, Kelehans Pub and Bushypark Church are located to the north of the proposed road development and outside the proposed development boundary (see also **Chapter 18, Human Beings, Population and Health**).

There is housing located on both sides of the N59 Moycullen Road where the proposed road development traverses it at Dangan.

The NUIG Sporting Campus is also located at Dangan and is traversed by the proposed road development with the IDA Galway Business Park immediately south of these facilities and outside of the proposed development boundary. The sporting campus consists of a number of playing pitches including hockey and GAA and a sports pavilion. There is planning permission for flood lighting of the sports pitches to the south of the proposed road development on the western bank of the River Corrib. The sporting campus facility is also a public amenity as it is used by many other sports clubs within Galway (see also **Chapter 18, Human Beings, Population and Health**).

The banks of the River Corrib and the River Corrib itself are an important recreational area serving the population of Galway (see also **Chapter 18, Human Beings, Population and Health**).

15.3.1.3 River Corrib to N84 Headford Road – Ch. 9+300 to Ch. 12+150

Menlo Castle is situated on the eastern bank of the River Corrib in the townland of Menlough (see also **Chapter 13, Archaeological, Architectural and Cultural Heritage**). The proposed road development proceeds east from here on an embankment towards a viaduct in Coolough, Menlough before entering a tunnel immediately west of Lackagh Quarry (an inactive quarry in the townland of Coolough) and emerging in Lackagh Quarry (see also **Chapter 9, Soils and**

Geology). The lands east of the River Corrib in Menlough are rural with sporadic one off housing.

To the east of Lackagh Quarry the proposed road development traverses the N84 Headford Road and passes through the townlands of Ballinfoyle and Ballindooley. A number of individual dwellings in a small community are located either side of the N84 Headford Road. To the south of the proposed road development there is a scrapyard and plant hire business on the western side of N84 Headford Road and a company which source and bottle water and is a distribution centre on the eastern side of the N84 Headford Road (see also **Chapter 18, Human Beings, Population and Health**).

15.3.1.4 N84 Headford Road to N83 Tuam Road – Ch. 12+150 to Ch. 14+000

From the N84 Headford Road the proposed road development proceeds east crossing the townland of Castlegar before crossing the N83 Tuam Road[4]. The community of Castlegar is comprised of rural individual dwellings, along with a primary school and a newly constructed nursing home. Castlegar National School is located north of the proposed road development and the nursing home to the south. There is a mix of commercial, residential and zoned lands located on the N83 Tuam Road. The City North Business Park is located along the eastern side of N83 Tuam Road, which includes a car dealership and An Post parcel depot. On the western side of the N83 Tuam Road there is a builder’s supplier’s warehouse. See also **Chapter 18, Human Beings, Population and Health**.

15.3.1.5 N83 Tuam Road to existing N6, Coolagh – Ch. 14+000 to Ch. 17+450

East of the N83 Tuam Road the proposed road development traverses the townlands of Parkmore, Ballybrit, Briarhill and Coolagh. The proposed road development enters a tunnel as it traverses the Galway Racecourse in Ballybrit. Race meetings take place at this location four times a year with the main race meeting, the Galway Races, occurring annually in the last week of July. This is a major event for the city of Galway. There are a number of commercial and industrial areas including the Parkmore, Ballybrit and City East Business Parks. There are also individual dwellings in this area. See also **Chapter 18, Human Beings, Population and Health**.

The proposed Parkmore Link Road will make use of an existing cul-de-sac access road serving Hewlett Packard and Boston Scientific. Boston Scientific recently acquired lands to the east of the existing IDA road, the former APC site, a total area of 12.6 hectares. The alignment of the link road has been designed to take account of Boston Scientific’s plans to expand the existing facility and utilise the acquired APC site. This expansion involves the redevelopment of the existing buildings and the full integration of the existing buildings with the new facilities within the APC site. The first phase of the expansion plans includes the construction of a building immediately adjacent to and interlinked with the existing northern building. This

[4] Formally known as the N17 Tuam Road

will allow product and people to move throughout the expanded site without the need to move from a controlled sterile environment. It will be necessary for vehicles and workers to cross the link road to access other parts of the landholding that are included in future phases of the expansion plans.

The proposed road development ties into the existing N6 at Coolagh west of Coolagh Village. This is a rural community of ribbon development housing. The land is mainly used for agricultural purposes. The area outside of Coolagh village both north and south of the existing N6 has been zoned within the Galway City Development Plan 2017 - 2023 and included within the Ardaun Local Area Plan 2018 - 2024.

15.3.2 Material Assets Non-Agriculture – services

15.3.2.1 Electric Supply

A number of existing 110 kilovolt (kV) electricity transmission circuits (which are owned by ESB Networks and operated by EirGrid) traverse the corridor of the proposed road development and are widespread throughout the study area. These comprise both overhead power lines as well as an underground cable circuit. In addition, a significant number of existing low voltage (38kV) electricity distribution overhead circuits (which are owned and operated by ESB Networks) are located within or adjacent to the corridor of the proposed road development. A number of these existing electricity circuits cross the corridor of the proposed road development, and consequently require a local diversion and/or modification to facilitate the proposed road development. There is an existing ESB distribution substation located in Ballybrit.

The proposed road development traverses the existing 110kV lines at four areas (townlands) and existing 38kV lines at 12 areas as listed below in **Table 15.3** and shown on **Figures 15.1.1** to **15.1.15**.

Each of the proposed consequential local diversions associated with electrical services have been identified and planned in detailed engagement with ESB Networks and EirGrid in the preparation of this planning application and EIA Report. These consultations will continue prior to and during the construction phase of the proposed road development. A working group has been formed with ESB Networks, EirGrid, ESBI (the technical and environmental consultations to ESB Networks) and the design team so that all issues, concerns, plans etc. are identified and discussed in a coordinated manner.

Table 15.3: Locations where the proposed road development traverses existing 110kV and 38kV lines

Approx. Chainage	Townland	Description
Ch. 3+900	An Chloch Scoilte	ESB Networks 110kV Overhead Service
Ch. 6+200 (Gort Na Bró Roundabout)	Knocknacarra	ESB Networks 110kV Underground Service
Ch. 13+530	Castlegar	ESB Networks 110kV Overhead Service
Ch. 14+000 (City Business Park)	Ballybrit	ESB Networks 110kV Overhead Service
Ch. 14+375	Ballybrit	ESB Networks 110kV Overhead Service
Ch. 14+400	Ballybrit	ESB Networks 110kV Overhead Service
Ch. 16+250	Coolagh	ESB Networks 110kV Overhead Service
Ch. 16+400	Coolagh	ESB Networks 110kV Overhead Service
Ch. 8+500	Dangan	ESB Networks 110kV Underground Service
Ch. 9+120	Dangan	ESB Networks 110kV Underground Service
Ch. 10+120	Menlo	ESB Networks 110kV Underground Service
Ch. 0+900	Na Foraí Maola	ESB Networks 38kV Overhead Service
Ch. 1+000	Na Foraí Maola	ESB Networks 38kV Overhead Service
Ch. 3+825	An Chloch Scoilte	ESB Networks 38kV Overhead Service
Ch. 5+750	Ballyburke	ESB Networks 38kV Overhead Service
Ch. 6+385	Rahoon	ESB Networks 38kV Underground Service
Ch. 6+550	Rahoon	ESB Networks 38kV Overhead Service
Ch. 6+650	Rahoon	ESB Networks 38kV Underground Service
Ch. 6+950 (Bothar Diarmuida Junction)	Rahoon	ESB Networks 38kV Overhead Service
Ch. 7+850 (Ballagh)	Bushypark	ESB Networks 38kV Overhead Service
Ch. 8+270	Barnacranny	ESB Networks 38kV Overhead Service
Ch. 8+270	Dangan	ESB Networks 38kV Underground Service
Ch. 8+450	Dangan	ESB Networks 38kV Underground Service
Ch. 8+550	Dangan	ESB Networks 38kV Overhead Service
Ch. 9+050	Dangan / Menlo	ESB Networks 38kV Overhead Service
Ch. 10+550	Coolough	ESB Networks 38kV Overhead Service
Ch. 13+830	Parkmore	ESB Networks 38kV Overhead Service
Ch. 14+400	Ballybrit	ESB Networks 38kV Overhead Service
Ch. 14+470	Ballybrit	ESB Networks 38kV Overhead Service
Ch. 14+500	Ballybrit	ESB Networks 38kV Underground Service
Ch. 15+860	Coolagh	ESB Networks 38kV Underground Service
Ch. 16+350 – 16+800	Coolagh	ESB Networks 38kV Overhead Service

15.3.2.2 Telecommunications

Telecommunication services are provided throughout the study area by the following providers:

- Eir
- BT Ireland
- Virgin Media
- Three
- E-Net
- Vodafone

Eir operate a customer service network routed both overhead along local roads and underground along the verges of the existing road network which are traversed by the proposed road development and are widespread throughout the study area.

BT Ireland operate a network line along the existing N6, Bóthar na dTreabh and internal within the industrial estates and business parks on the east side of the city.

Virgin Media have a fibre optic cable along the existing Letteragh Road, within business parks and beneath the local roads in large residential housing estates.

Three Networks Ireland have a telecommunications mast located at Ch. 14+500 in Ballybrit which provides a mobile service to Galway City and County.

E-Net provide a fibre optic broadband network cable within Galway City and this is crossed multiple times by the proposed road development on the eastern side of the city.

There is a Vodafone telecommunications mast at Ch. 4+550 which provides a mobile service to Galway City and County.

15.3.2.3 Gas Supply

Gas Networks Ireland (GNI) manages the national natural gas transmission and distribution network in Ireland. The supply is via a small number of high pressure transmission mains. These transmission lines then branch off as distribution lines which serve the residential areas and follow housing estate patterns.

The proposed road development crosses the gas transmission and distribution lines at the following locations which are also shown in **Figures 15.2.1** to **15.2.5**:

- Ch. 6+200 (Western Distributor Road) – distribution network
- Ch. 6+550 (Rahoon Road Junction) – distribution network
- Ch. 6+900 (Bóthar Diarmuida Junction) – distribution network
- Ch. 13+150 (School Road, Castlegar) – this transmission network is the main gas supply for Galway City
- Ch. 15+500 (Parkmore Link Road) – distribution network

- Ch. 16+650 (Doughiska) – distribution network

15.3.2.4 Public Water Supply and Foul Water Supply

Galway City and County Councils in conjunction with Irish Water have potable water infrastructure serving the settlement areas within the study area. Properties located in the urban area around Galway City are generally connected to the public watermains. There are also dwellings within the proposed development boundary that have private wells. There are no private group water schemes within the proposed development boundary. The proposed road development traverses a number of watermains in both the rural and urban areas.

The local authorities and Irish Water also have surface water and foul water sewers in areas within the study area. The proposed road development traverses a number of foul and surface water sewers in the urban areas. There is one private sewer in Ballybrit that will also be traversed by the proposed road development. The majority of properties in the rural areas within the study area utilise septic tanks.

There are two reservoirs within the study area, in the vicinity of the proposed road development but outside of the proposed development boundary, one located in Letteragh and the second in Coolagh, Briarhill.

15.4 Characteristics of the Proposed Road Development

Galway City and its environs have critical transport issues that require urgent resolution as detailed in **Chapter 3, Need for the Proposed Road Development**. There are however significant constraints for developing new transport infrastructure for Galway given (i) the physical form of the city, (ii) the limited space available, (iii) the built environment and residential areas on both sides of the River Corrib, and (iv) the presence of designated sites.

The proposed road development is the optimum transport solution to resolve the transport issues in Galway and although its route has been designed to skirt the city and lands zoned for development, given the built environment, the linear development of the city with housing along every road radiating out of the city and the unavoidable proximity to residential areas, the proposed road development will unfortunately and unavoidably result in a number of property demolitions.

This must however, be viewed and balanced in the context of the overall benefit, described in **Chapter 3, Need for the Proposed Road Development**, that the proposed road development will deliver for the future of Galway and its environs and connectivity to the Western Region.

Numerous alternatives have been considered as detailed in **Chapter 4, Alternatives Considered**, however the conclusion of the consideration of the alternatives is that the proposed road development represents the optimum transport solution and has avoided the greatest number of known and immovable constraints and is the option that overall has a lesser environmental impact taking all other potential environmental impacts into account.

Further, once chosen, the design of the emerging preferred route has been refined in as much as possible to eliminate and reduce impacts on the human environment. As discussed in **Chapter 4, Alternatives Considered**, significant design measures such as steeper earthwork slopes, steepened green embankments and retaining walls are employed in the scheme design to minimise the impact on the human environment. Additional mitigation measures such as noise barriers, landscaping, planting, earth bunding are also utilised to minimise the overall impact on the receiving environment as discussed in **Chapter 12, Landscape and Visual** and **Chapter 17, Noise and Vibration**.

The proposed road development is consistent with proper planning and sustainable development and this view is supported / validated by the inclusion of policy support for both GTS and constituent measures, including the proposed road development, in the relevant Galway Development Plans.

A detailed description of the proposed road development, including the localised works to the existing electricity transmission and distribution networks, and construction activities are provided in **Chapter 5, Description of Proposed Road Development** and **Chapter 7, Construction Activities**. This section outlines the characteristics and activities of the proposed road development of relevance to material assets non-agriculture.

15.4.1 Construction Phase

The construction of the proposed road development will require the acquisition of approximately 184 hectares of non-agricultural land and the demolition and acquisition of residential, commercial and industrial properties as described in **Section 15.5**. All construction activities will be carried out within the proposed development boundary. The construction of the proposed road development will also require localised works to the existing electricity transmission and distribution networks (specifically comprising the diversion of the 110kV and 38kV as shown on **Figures 15.1.1** to **15.1.15**), gasmains, water supply and foul water services. Road closures and temporary traffic diversions are assessed in **Chapter 7, Construction Activities**.

At the beginning of the construction phase the land to be acquired will be fenced and access across it is restricted. In certain situations, temporary crossing points will be facilitated until accommodation roads are constructed. Properties will be acquired and demolished or secured for the duration of the works. Construction of the proposed road development will require activities such as excavation, tunnel work, piling, rock breaking and movement of materials within the fenced off works area (ref. **Chapter 7, Construction Activities**). This will generate noise, dust and movement of machinery which will potentially impact on adjoining lands in addition to visual impacts and these indirect impacts on material assets non-agriculture are assessed in **Chapter 12, Landscape and Visual**, **Chapter 16, Air Quality and Climate**, **Chapter 17, Noise and Vibration** and **Chapter 18, Human Beings, Population and Health**. There are no known indirect effects from the proposed road development on material assets non-agriculture as all potential impacts regardless of the scale, for example a right of way, are considered to be direct.

15.4.2 Operational Phase

Once the proposed road development is operational, all remaining properties will have access; all utilities and services will operate and function to a level of service as is the current situation with the exception of NUIG Sporting Campus which will require a full reconfiguration of its masterplan to facilitate the proposed road development. The proposed road development itself will become an additional material asset non-agriculture.

15.5 Evaluation of Impacts

15.5.1 Do Nothing Impact

In the event of the proposed road development not being constructed, the existing N6, Bóthar na dTreabh and the Quincentenary Bridge will remain the major route for traffic crossing the River Corrib and travelling from the east to west County Galway. The potential impacts, in terms of on material assets non-agriculture would essentially remain the same as the current situation. The proposed property acquisition and impacts on services will not be required.

15.5.2 Potential Construction Impacts

The proposed road development has been designed to avoid as many properties as possible but given the built environment and the linear development of the city with housing along every road radiating out of the city its construction will unfortunately and unavoidably result in a number of property acquisitions or demolitions.

In total there are 313 non-agriculture properties directly impacted by the proposed road development, i.e. full acquisition or partly acquisition of the property. The direct impacts on non-agricultural properties are detailed in the following sections:

- **Section 15.5.2.1** – Full acquisition or demolition of: residential, commercial or industrial properties; landholdings zoned for residential or commercial development; and lands with full planning permission which are to be fully acquired
- **Section 15.5.2.2** – Partial acquisition of lands from a residential property or landholding zoned for residential development
- **Section 15.5.2.3** – Partial acquisition of lands from a commercial or industrial enterprise or landholding zoned for commercial or industrial development
- **Section 15.5.2.4** – Partial acquisition of lands from other holdings not included above for example education facilities and Galway Racecourse
- **Section 15.5.2.5** – Planning permissions to be revoked or modified as a result of the proposed road development
- **Section 15.5.2.6** – Potential Impacts to utilities and services

Potential indirect impacts on material assets non-agriculture from factors such as landscape and visual, air, noise, human beings are assessed in **Chapter 12,**

Landscape and Visual, **Chapter 16, Air Quality and Climate**, **Chapter 17, Noise and Vibration** and **Chapter 18, Human Beings, Population and Health**.

In some cases, the proposed road development will require the acquisition of land over which there is a public right of way which entails the acquisition of road bed at the front of certain properties. The road bed comprises that portion of land outside a property's boundary wall to the centre of the public road which is in private ownership but in public use. These lands are occupied by existing roads but remain in the ownership of the adjacent property. These lands are outside the curtilage of the property therefore the impact is imperceptible as defined in **Table 15.2**. The proposed road development will also remove a number of existing private rights of way.

Where there is an impact on existing services during the construction phase an alternative supply will be made available. It will be necessary to maintain supply to existing services, as far as possible, during construction. Achieving this may entail temporary diversions of services and / or staging of the works. There may also be short periods where outages of the services are required to facilitate the construction. These outages will be kept to a minimum and people using these services will be given due notification in advance of any outage.

15.5.2.1 Residential, Commercial or Industrial Properties to be Fully Acquired or Demolished

From the outset of the design of the proposed road development every effort was made to avoid property demolitions where possible. However, there are still unfortunately and unavoidably a number of property demolitions that are necessary for the construction of the proposed road development and to secure the many benefits the proposed road development offers as follows:

- 44 residential properties
- 2 industrial properties (one property includes four buildings)
- 2 commercial properties

In addition to the demolition of 44 residential properties, an additional 10 residential properties, one commercial property and one landholding that has a full residential planning permission require full acquisition.

All 60 of these properties are listed below in **Table 15. 4** and shown in **Figures 14.1.1** to **14.1.15** and **Figures 15.3.01** to **15.3.15**.

Whilst this is a large number of property impacts with the associated impacts on families living in them, the overall context of the impacts is assessed against the potential benefits that can be accrued from the proposed road development, including the very significant and very much needed benefits to Galway City and its environs and connectivity to the Western Region and the European TEN-T network. A detailed analysis of the impact of the proposed road development on the community is presented in **Chapter 18, Human Beings, Population and Human Health**.

Table 15.4: Residential, Commercial or Industrial Properties to be Fully Acquired or Demolished

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
118	Na Foraí Maola Thiar	House and garden	0.226	Demolition of house and garden	0.226	Significant
121	Na Foraí Maola Thiar	House and garden	1.081	Demolition of house and garden	1.081	Significant
122	Na Foraí Maola Thiar	House and garden	0.385	Demolition of house and garden	0.385	Significant
123	Na Foraí Maola Thiar	House and garden	0.223	Acquisition of house and garden	0.223	Moderate
124***	Na Foraí Maola Thiar	Full residential planning permission	0.470	Acquisition of whole site	0.470	Moderate
133	Na Foraí Maola Thoir	House and garden	0.307	Demolition of house and garden	0.307	Significant
157	Na Foraí Maola Thoir	House and garden	0.383	Acquisition of house and garden	0.383	Moderate
154 *	Troscaigh Thiar	House and garden	2.383	Demolition of house, buildings and garden	1.804	Significant
203	Cloghscoltia	House and garden	0.403	Acquisition of house and garden	0.403	Moderate
206	Ballard East	House and garden	0.206	Acquisition of house and garden	0.206	Moderate
230 * (**)	Keeraun	House and garden and surrounding lands	10.486	Demolition of house and garden and partial landtake	2.093	Significant
253	Rahoon	House and garden	0.142	Demolition of house and garden	0.142	Significant
457 *	Barnacranny	House and garden	5.539	Demolition of house and garden	4.057	Significant
457 *	Barnacranny	House and garden	5.539	Acquisition of house and garden	4.057	Moderate

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
497	Ballagh	House and garden	0.436	Demolition of house and garden	0.436	Significant
498 *	Ballagh	House and garden	2.681	Acquisition of house and garden	1.183	Moderate
518	Dangan Upper	House and garden	0.304	Acquisition of house and garden	0.304	Moderate
520	Dangan Upper	House and garden	0.274	Demolition of house and garden	0.274	Very Significant
519	Dangan Upper	House and garden	0.259	Demolition of house and garden	0.259	Very Significant
530	Dangan Lower	House and garden	0.281	Demolition of house and garden	0.281	Very Significant
537	Dangan Lower	House and garden	0.353	Demolition of house and garden	0.353	Very Significant
538	Dangan Lower	House and garden	0.329	Demolition of house and garden	0.329	Very Significant
539	Dangan Lower	House and garden	0.308	Demolition of house and garden	0.308	Very Significant
540	Dangan Lower	House and garden	0.372	Demolition of house and garden	0.372	Very Significant
532	Dangan Lower	House and garden	0.251	Acquisition of house and garden	0.251	Moderate
567	Menlough	House and garden	0.425	Demolition of house and garden	0.425	Significant
568	Menlough	House and garden	0.424	Demolition of house and garden	0.424	Significant
583*	Coolough	Quarry	20.913	Acquisition of whole quarry site	20. 760	Significant
610	Ballindooley	House and garden	0.085	Demolition of house and garden	0.085	Very Significant
614	Ballindooley	House and garden	0.119	Demolition of house and garden	0.119	Very Significant

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
613	Ballindooley	House and garden	0.192	Demolition of house and garden	0.192	Very Significant
657	Ballindooley	House and garden	0.158	Demolition of house and garden	0.158	Very Significant
615	Ballindooley	House and garden	0.131	Demolition of house and garden	0.131	Very Significant
621	Ballindooley	House and garden	0.312	Demolition of house and garden	0.312	Very Significant
612	Ballindooley	House and garden	0.075	Demolition of house and garden	0.075	Very Significant
601 * (**)	Ballindooley	House and garden	1.049	Demolition of house and garden	1.049	Very Significant
609	Ballindooley	House and garden	0.079	Demolition of house and garden	0.079	Very Significant
616	Ballindooley	House and garden	0.174	Demolition of house and garden	0.174	Very Significant
617	Ballindooley	House and garden	0.048	Demolition of house and garden	0.048	Very Significant
619	Castlegar	House and garden	0.099	Demolition of house and garden	0.099	Very Significant
611	Ballindooley	House and garden	0.226	Demolition of house and garden	0.226	Very Significant
618	Castlegar	House and garden	0.075	Demolition of house and garden	0.075	Very Significant
636/637	Castlegar	House and garden	0.195	Acquisition of house and garden	0.195	Moderate
633	Castlegar	House and garden	0.351	Demolition of house and garden	0.351	Very Significant
632 *	Castlegar	House and garden	2.224	Demolition of house and garden	2.224	Very significant
652	Castlegar	House and garden	0.170	Demolition of house and garden	0.170	Very Significant

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
643	Castlegar	House and garden	0.124	Demolition of house and garden	0.124	Very Significant
644	Castlegar	House and garden	0.120	Demolition of house and garden	0.120	Very Significant
642	Castlegar	House and garden	0.193	Demolition of house and garden	0.193	Very Significant
631 **	Castlegar	House and garden and light residential zoned lands	6.810	Acquisition of house and garden	0.763	Moderate
658 *	Castlegar	House and garden	16.914	Demolition of house and garden	1.669	Significant
673	Cappanabornia	Builders Providers (commercial lands) including warehouse and yard	1.316	Demolition of warehouses & partial landtake	0.768	Very Significant
671 * (**)	Castlegar	House and garden and residential zoned lands	2.833	Demolition of house and garden and full landtake	2.833	Significant
672	Castlegar	House and garden	0.151	Demolition of house and garden	0.151	Significant
713 **	Ballybrit	Builders Suppliers / Industrial Zoned Lands	1.106	Demolition	1.106	Very Significant
708	Ballybrit	Industrial - unfinished build	1.141	Demolition of 4 buildings	1.141	Significant
711	Ballybrit	Industrial - unfinished build	0.259	Demolition	0.259	Significant
701* (**)	Ballybrit	House and garden and industrial zoned lands	5.972	Demolition of house and garden and partial landtake	4.246	Significant
725	Doughiska / Coolagh	House and garden	0.213	Demolition of house and garden	0.213	Significant

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
724 **	Doughiska / Coolagh	Two houses and garden and zoned lands	4.074	Demolition of 2 houses and garden and partial landtake	2.717	Significant

Note:

** this property is also dealt with in **Chapter 14, Material Assets Agriculture** as the property to be demolished is part of an agricultural property and areas quotes include agricultural lands*

*** this property also includes zoned lands (and are also included in **Tables 15.6** and **15.7** below and areas quotes include those lands.*

**** at the time of writing sites have valid planning permission*

15.5.2.2 Partial Land Acquisition of Residential Properties

The proposed road development will require the partial acquisition of lands such as gardens and paved areas, part of which may also include road bed in front of houses, from residential properties or land holdings zoned for residential development as follows:

- 76 residential properties

There are also a number of "road bed only acquisitions" where road bed owned by a private residential property or residential development over which there is a public right of way only is required to be acquired. These include the following:

- 58 residential properties

All of these 134 properties are listed below in **Table 15.5** and shown on **Figures 14.1** to **14.15**. Compensation for these impacts are to be agreed by a valuer at a later stage after appropriate liaison with the property owners affected.

There will also be road bed purchased adjacent to agricultural properties which is assessed in **Chapter 14, Material Assets Agriculture**, however this has not been quantified in this chapter.

Table 15.5: Partial Land Acquisition of Residential Properties

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
103 *	An Baile Nua	House and garden	4.127	Part of Garden and Road Bed	0.151	Slight
101 *	An Baile Nua	House and garden	3.081	Road Bed	0.138	Imperceptible
104	Na Foraí Maola Thiar	House and garden	0.292	Part of garden and Road Bed	0.051	Slight
146 *	Na Foraí Maola Thoir	House, Barn and garden	6.905	Part of garden and Road Bed	4.121	Slight
138	Na Foraí Maola Thiar	House and garden	0.379	Road Bed	0.040	Imperceptible
142	Na Foraí Maola Thiar	House and garden	0.426	Part of garden	0.005	Slight
119	Na Foraí Maola Thiar	House and garden	0.462	Part of garden	0.016	Slight
129	Na Foraí Maola Thoir	House and garden	0.488	Part of garden and Road Bed	0.018	Slight
132	Na Foraí Maola Thoir	Garden	0.029	Road bed	0.009	Imperceptible
127	Na Foraí Maola Thiar	House and garden	0.160	Part of garden and Road Bed	0.008	Slight
135	Na Foraí Maola Thoir	House and garden	0.214	Road Bed	0.021	Imperceptible
130	Na Foraí Maola Thoir	House and garden	0.264	Part of garden and Road Bed	0.076	Slight
131	Na Foraí Maola Thoir	House and garden	0.186	Part of garden and Road Bed	0.036	Moderate
136	Na Foraí Maola Thoir	House and garden	0.216	Road Bed	0.019	Imperceptible
125	Na Foraí Maola Thiar	House and garden	0.410	Part of garden	0.072	Slight
149 **	Troscaigh Thiar	Site	0.200	Road Bed	.0075	Imperceptible
237	Na Foraí Maola Thiar	House and garden	0.426	Part of garden and Road Bed	0.071	Slight
137	Na Foraí Maola Thiar	House and garden	0.229	Road Bed	0.014	Imperceptible
134	Na Foraí Maola Thoir	House and garden	0.942	Part of garden and Road Bed	0.429	Moderate
145*	Na Foraí Maola Thoir	House and garden	2.625	Road Bed	0.736	Imperceptible
139	Na Foraí Maola Thiar	House and garden	0.370	Road Bed	0.014	Imperceptible
303	Na Foraí Maola Thiar	House and garden	0.226	Road Bed	0.013	Imperceptible

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
302	Na Foraí Maola Thiar	House and garden	0.226	Road Bed	0.015	Imperceptible
152	Troscaigh Thiar	House and garden	0.225	Part of garden and Road Bed	0.024	Slight
162	Troscaigh Thiar	House and garden	0.374	Road Bed	0.019	Imperceptible
155	Troscaigh Thiar	House and garden	0.136	Part of garden and Road Bed	0.024	Moderate
151	Troscaigh Thiar	House and garden	0.227	Part of garden and Road Bed	0.021	Slight
148	Troscaigh Thiar	House and garden	0.222	Road Bed	0.012	Imperceptible
150	Troscaigh Thiar	House and garden	0.197	Part of garden and Road Bed	0.023	Slight
158	Na Foraí Maola Thoir	House and garden	0.220	Part of garden and Road Bed	0.029	Slight
159	Na Foraí Maola Thoir	House and garden	0.212	Part of garden and Road Bed	0.033	Slight
163	Troscaigh Thiar	House and garden	0.229	Part of garden and Road Bed	0.047	Moderate
161	Troscaigh Thiar	House and garden	0.263	Part of garden and Road Bed	0.012	Slight
147*	Troscaigh Thiar	House and garden	4.091	Part of garden and Road Bed	0.082	Slight
180	Troscaigh Thiar	House and garden	0.269	Road Bed	0.006	Imperceptible
178	Troscaigh Thoir	House and garden	0.187	Road Bed	0.007	Imperceptible
185	Troscaigh Thoir	House and garden	0.364	Road Bed	0.017	Imperceptible
188	Troscaigh Thiar	House and garden	0.438	Road Bed	0.002	Imperceptible
189	Troscaigh Thiar	House and garden	0.235	Road Bed	0.005	Imperceptible
184	Troscaigh Thoir	House and garden	0.397	Road Bed	0.019	Imperceptible
181	Troscaigh Thoir	House and garden	0.453	Road Bed	0.012	Imperceptible
183	Troscaigh Thoir	House and garden	0.242	Road Bed	0.012	Imperceptible
179	Troscaigh Thoir	House and garden	0.238	Road Bed	0.015	Imperceptible
174 *	Troscaigh Thiar	House, garden and outbuildings	6.285	Road Bed	0.140	Imperceptible
195	Troscaigh Thoir	House and garden	1.963	Part of garden and Road Bed	1.023	Moderate
141	Na Foraí Maola Thoir	House and garden	0.195	Part of garden and Road Bed	0.009	Slight
190	Troscaigh Thiar	House and garden	0.157	Road Bed	0.000	Imperceptible

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
177 *	Troscaigh Thoir	House and garden	5.812	Road Bed	0.115	Imperceptible
201	Cloghscoltia	House and garden	0.324	Road Bed	0.002	Imperceptible
202	Cloghscoltia	House and garden	0.299	Part of garden and Road Bed	0.050	Slight
207	Ballard West	House and garden	0.425	Part of garden and Road Bed	0.049	Slight
204*	Cloghscoltia	House and garden	0.400	Part of garden and Road Bed	0.038	Slight
222	Cappagh	House and garden	0.263	Part of garden and Road Bed	0.038	Slight
221	Cappagh	House and garden	0.206	Part of garden and Road Bed	0.021	Slight
218	Cappagh	House and garden	0.204	Part of garden and Road Bed	0.022	Slight
219	Cappagh	House and garden	0.261	Part of garden and Road Bed	0.020	Slight
220	Cappagh	House and garden	0.200	Road Bed	0.013	Slight
215	Cappagh	House and garden	0.282	Part of garden and Road Bed	0.044	Moderate
216*	Cappagh	House and garden	3.787	Part of garden and Road Bed	0.208	Slight
213 *	Cappagh	House, Barn and Garden	8.801	Part of garden and entrance and Road Bed	2.032	Moderate
304*	Cappagh	House and garden	0.637	Road Bed	0.042	Imperceptible
306	Cappagh	House and garden	0.302	Road Bed	0.007	Imperceptible
305	Cappagh	House and garden	0.526	Road Bed	0.017	Imperceptible
232	Bearna	House and garden	4.269	Part of garden and Road Bed	0.201	Moderate
229 * (**)	Ballyburke	House and garden, residential zoned lands	9.199	Part of garden and Road Bed	1.447	Moderate
234	Keeraun	House and garden	0.434	Part of garden and Road Bed	0.032	Slight
235*	Keeraun	House and garden	0.809	Road Bed	0.057	Imperceptible
244	Mincloon	House and garden	0.244	Road Bed	0.018	Imperceptible
272_462 **	Letteragh	House and garden	9.367	Part of garden and Road Bed	2.807	Slight
252*	Rahoon	House, stables and garden	0.300	Part of garden and Road Bed	0.040	Moderate
298	Rahoon	House, barn and garden	0.687	Part of garden	0.059	Slight
255	Rahoon	House and garden	0.224	Part of garden and entrance and Road Bed	0.035	Slight
296	Rahoon	House and garden	0.171	Part of garden and Road Bed	0.035	Moderate

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
486 *	Letteragh	House and garden	1.510	Part of garden and Road Bed	0.194	Moderate
259_463 *	Rahoon)	House and garden	8.567	Part of garden and Road Bed	0.647	Moderate
490	Bushypark/ Ballagh	House and garden	0.737	Road Bed	0.027	Imperceptible
491	Bushypark	House and garden	0.779	Road Bed	0.012	Imperceptible
492	Bushypark/ Ballagh	House and garden	0.270	Part of Garden and Road Bed	0.003	Slight
493	Bushypark/ Ballagh	House and garden	0.487	Part of garden and Road Bed	0.086	Slight
494	Ballagh	House and garden	0.362	Part of garden and Road Bed	0.067	Slight
496 *	Bushypark/ Ballagh	House and garden	2.170	Part of garden and Road Bed	0.690	Slight
515	Dangan Upper	House and garden	0.303	Part of garden	0.042	Moderate
527	Dangan Upper / Dangan Lower	House and garden	0.382	Road Bed	0.065	Imperceptible
524	Dangan Upper	House and garden	0.550	Part of garden and Road Bed	0.157	Moderate
512	Dangan Upper/ Barnacranny	House and garden	0.336	Part of garden	0.006	Slight
533	Dangan Lower	House and garden	0.620	Part of garden and Road Bed	0.129	Moderate
534	Dangan Lower	House and garden	0.322	Part of garden and Access Road Bed	0.017	Slight
536	Dangan Lower	House and garden	1.807	Road Bed	0.011	Imperceptible
535	Dangan Lower	House and garden	0.592	Part of garden and Road Bed	0.075	Slight
529	Dangan Lower /Dangan Upper	Residential Estate	0.250	Road Bed and Access Road Bed	0.015	Imperceptible
523	Dangan Upper	House and garden	0.215	Part of garden and Road Bed	0.028	Slight
569	Mionlach (Menlough)	House and garden	0.322	Part of garden and Road Bed	0.026	Slight
576 *	Menlough/ Coolagh	House and garden	0.515	Part of garden and Road Bed	0.266	Slight
577	Menlough	House and garden	0.370	Part of garden	0.009	Slight
550	Coolagh	House and garden	0.538	Road Bed	0.003	Imperceptible
575	Coolagh	House and garden	0.212	Road Bed	0.009	Imperceptible
558	Menlough	House and garden	0.387	Road Bed	0.007	Imperceptible
589	Coolagh	House and garden	0.365	Road Bed	0.009	Imperceptible
594	Coolagh	House and garden	0.238	Road Bed	0.025	Imperceptible
604	Ballindooley	House and garden	0.518	Part of garden and Road Bed	0.045	Slight
620, 664 **	Castlegar	House and garden	6.622	Part of garden and Road Bed	0.205	Slight

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
607	Ballindooley	House and garden	0.180	Road Bed	0.024	Imperceptible
608	Ballindooley	House and garden	0.230	Part of garden and Road Bed	0.031	Slight
603 *	Ballindooley	House and garden	0.571	Road Bed	0.251	Moderate
622	Ballindooley	House and garden	2.046	Part of Garden and Road Bed	0.004	Slight
639	Castlegar	House and garden	0.254	Part of Garden Road Bed	0.014	Slight
638	Castlegar	House and garden	0.221	Part of garden and Road Bed	0.030	Slight
641	Castlegar	House and garden	0.162	Road Bed	0.018	Imperceptible
634	Castlegar	House and garden	0.309	Part of garden	0.006	Slight
653	Castlegar	House and garden	0.386	Part of garden (Demolition of shed)	0.061	Moderate
654	Castlegar	House and garden	0.203	Part of garden and Access Road	0.031	Slight
640	Castlegar	House and garden	0.439	Road Bed	0.005	Imperceptible
645	Castlegar	House and garden	0.113	Road Bed	0.017	Imperceptible
646	Castlegar	House and garden	0.120	Road Bed	0.021	Imperceptible
682	Cappanabornia	House and garden	0.703	Part of garden and Access Road	0.032	Slight
674	Cappanabornia	House and garden	0.283	Part of garden and Road Bed	0.092	Moderate
628**	An Caisleán Gearr (Castlegar)	House, garden and Zoned Lands	0.350	Part of garden and Partial landtake	0.024	Slight
629**	Castlegar	House, garden and Zoned Lands	0.419	Part of garden and Partial landtake	0.051	Slight
667	Parkmore	House and garden	0.248	Part of garden and Road Bed	0.075	Slight
680	Cappanabornia	House and garden	0.102	Road Bed	0.015	Imperceptible
679	Cappanabornia	House and garden	0.103	Road Bed	0.017	Imperceptible
678	Cappanabornia	House and garden	0.102	Road Bed	0.016	Imperceptible
677	Cappanabornia	House and garden	0.106	Road Bed	0.014	Imperceptible
676	Cappanabornia	House and garden	0.104	Road Bed	0.013	Imperceptible
675	Cappanabornia	House and garden	0.112	Road Bed	0.012	Imperceptible
683	Cappanabornia	House and garden	0.168	Part of Garden and Road Bed	0.009	Slight
687	Polkeen	House and garden	0.814	Road Bed	0.019	Imperceptible
686	Polkeen	House and garden	0.165	Road Bed	0.012	Imperceptible

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
666	Parkmore/ Castlegar	House and garden	0.363	Part of garden and Road Bed	0.115	Slight
663	Castlegar/Parkmore	House and garden	0.227	Part of garden and Road Bed	0.043	Slight
662	Castlegar	House and Garden	0.104	Road Bed	0.011	Imperceptible
700	Baile An Dúlaigh (Ballindooley)	House and Garden	0.130	Road Bed	0.012	Imperceptible
723	Breanloughaun	House and garden	0.147	Road Bed	0.011	Imperceptible
714 *	Breanloughaun/ Doughiska	House and garden	6.594	Part of garden and Road Bed	0.106	Moderate

*Note: * this property is also dealt with in **Chapter 14, Material Assets Agriculture** as the property to be demolished is part of an agricultural property and areas quotes include agricultural lands*
*** this property also includes zoned lands (and are also included in **Tables 15.6** and **15.7** below and areas quotes include those lands.*
**** at the time of writing sites have valid planning permission*

15.5.2.3 Partial Land Acquisition of Commercial or Industrial Enterprises

The proposed road development will require the partial acquisition of lands such as (i) green open spaces, (ii) paved surfaces for car parking from 17 commercial or industrial enterprises or landholdings zoned for commercial or industrial development as follows:

- Partial landtake from 12 commercial or industrial enterprises including car sales facilities, business parks, a company which source and bottle water, nursing home and is a distribution centre and An Post depot.
- Partial landtake from 5 landholdings zoned for commercial or industrial development

There are also a number of "road bed only acquisitions" where road bed owned by a commercial or industrial enterprise over which there is a public right of way only is acquired without any acquisition form the actual property itself. These include the following:

- 2 commercial or industrial enterprises

All of these properties are listed below in **Table 15.6** and shown in **Figures 14.1** to **14.15**. Compensation for these impacts are to be agreed by a valuer at a later stage after appropriate liaison with the property owners affected.

Table 15.6: Partial Land Acquisition from Commercial or Industrial Enterprises

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
452_479	Rahoon	Zoned Lands	11.222	Partial landtake and road bed	0.888	Slight
476	Rahoon	Retail Park	0.643	Roadbed	0.005	Imperceptible
480	Rahoon	Zoned Lands	9.609	Partial landtake and roadbed	1.302	Slight
602, 704, 698, 699	Castlegar /Ballindooley	Company which source and bottle water and is a distribution centre	9.028	Partial landtake and roadbed	1.842	Significant
656	Castlegar	Nursing Home and Zoned Lands	0.435	Road Bed and Access Road	0.079	Imperceptible
685	Cappanabornia / Polkeen	Quarry	66.1	Road Bed	0.023	Imperceptible
668	Parkmore / Castlegar	Business Park	6.839	Partial landtake and roadbed	0.939	Slight
696*	Ballybaan Beg / Parkmore / Ballybrit / Polkeen / Brockagh	Industrial Estate and zoned lands	38.541	Partial landtake and roadbed	3.19	Slight
697	Parkmore	Industrial Estate	5.122	Partial landtake and Roadbed	0.088	Slight
701*	Parkmore / Ballybrit	House, garden, and zoned lands	5.972	Partial landtake and roadbed	4.246	Moderate
707	Ballybrit	Industrial Estate and Zoned lands	2.506	Partial landtake and Road Bed	0.142	Slight
729	Ballybrit	Zoned Lands	1.861	Partial landtake and roadbed	0.282	Slight
695	Parkmore / Ballybaan Beg	Industrial plant	12.570	Partial landtake and access road	0.998	Moderate
717	Ballybrit	Car Sales	0.884	Partial landtake	0.045	Slight
721	Doughiska	Car Sales	0.773	Partial landtake (Paved area) and access road	0.080	Moderate
719	Doughiska	Retail Park	3.759	Partial landtake and access road	1.662	Slight
715	Doughiska / Ballybrit	Retail Park	4.407	Partial landtake and Road Bed	0.008	Imperceptible
716	Ballybrit	Zoned Lands	11.198	Partial landtake	1.920	Slight
720	Doughiska	Car Sales	0.200	Partial landtake (paved area)	0.008	Slight

Note: ** this property is also dealt with in* ***Chapter 14, Material Assets Agriculture*** *as the property to be demolished is part of an agricultural property and areas quotes include agricultural lands*

15.5.2.4 Land Acquisition of Other Non-Agricultural Properties

The remaining 107 land holdings are made up of (i) the acquisition of isolated roadbeds from 24 properties, (ii) the acquisition of river bed from two properties and (iii) and the partial acquisition of lands at the following properties:

- Galway County Council storage depot
- National University of Ireland (NUIG), Galway Sporting Campus facilities
- Castlegar National School
- Church at Bushypark
- Church at Coolagh
- Galway Racecourse
- Disused railway track

There is also acquisition of land 74 parcels of zoned lands.

These are listed below in **Table 15.7** and shown in **Figures 14.1.1** to **14.1.15**. Compensation for these impacts are to be agreed by a valuer at a later stage after appropriate liaison with the property owners affected.

The NUIG Sporting Campus facilities will be severely affected during the course of the construction works, as the central part of the sporting campus will become a construction site with restricted access for a period of approximately 18 months. Access to the bank of the River Corrib which is used as a local amenity and the river itself will also be restricted at times during construction. The existing sports pitches adjacent to the River Corrib will be unavailable for use for the duration of the construction of the new 3G sports pitches which is likely to be nine months. Once they are constructed they will be available for use within approximately one month.

Table 15.7: Land Acquisition of Other Non-Agricultural Properties

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
126	Na Foraí Maola Thiar	Galway County Council depot	0.140	Partial landtake and road bed	0.019	Slight
140	Na Foraí Maola Thiar	Road	1.037	Road bed	0.025	Imperceptible
182	Troscaigh Thiar	Road	0.022	Partial landtake	0.007	Imperceptible
156*	Na Foraí Maola Thoir	Road	0.552	Partial landtake and road bed	0.073	Slight
186	Troscaigh Thiar	Road	0.024	Road Bed	0.002	Imperceptible
187	Troscaigh Thiar	Road	0.017	Road Bed	0.013	Imperceptible
223 *	Cappagh / Keeraun / Ballynahown East / Clybaun / Mincloon	Zoned Lands	15.922	Partial landtake and road bed	3.320	Moderate
228 *	Ballynahown East	Zoned Lands	1.226	Partial landtake	0.123	Slight
230 *	Ballynahown East / Keeraun	Zoned Lands	10.486	Partial landtake	2.186	Moderate
231 *	Ballynahown East	Zoned Lands	6.772	Partial landtake	0.704	Slight
239 *	Keeraun / Mincloon	Zoned Lands	12.462	Partial landtake	2.589	Moderate
242 *	Mincloon	Zoned Lands	2.589	Partial landtake and road bed	0.079	Slight
261 *	Ballynahown East / Keeraun	Zoned Lands	6.480	Partial landtake	1.603	Moderate
299_459	Rahoon	Road	0.012	Road Bed	0.109	Imperceptible
310_458	Letteragh / Rahoon	Road	0.028	Road Bed	0.023	Slight
258_464 *	Rahoon / Letteragh	Zoned Lands	1.9	Partial landtake and road bed	0.204	Slight

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
483 *	Letteragh	Zoned Lands	0.485	Partial landtake	0.037	Slight
450 *	Letteragh	Zoned Lands	0.581	Partial landtake	0.012	Slight
227 *	Ballynahown East / Cappagh	Zoned Lands	1.833	Partial landtake	0.740	Moderate
257_465 *	Letteragh / Rahoon	Zoned Lands	0.325	Partial landtake	0.124	Slight
238 *	Mincloon / Keeraun	Zoned Lands	2.919	Partial landtake	0.950	Moderate
451	Bushypark	Disused Railway Track	0.033	Partial landtake	0.033	Slight
489*	Bushypark	Zoned lands	1.731	Partial landtake	1.181	Slight
469	Rahoon	Zoned Lands	9.255	Partial landtake	0.926	Moderate
470 *	Menlough	Zoned Lands	0.657	Full landtake	0.657	Moderate
471 *	Menlough	Zoned Lands	0.991	Partial landtake	0.461	Slight
472 *	Menlough	Zoned Lands	0.763	Full landtake	0.763	Moderate
473	Rahoon	Zoned Lands	1.871	Partial landtake	0.027	Slight
477	Rahoon	Road	0.292	Road Bed	0.144	Imperceptible
475*	Rahoon	Road	1.645	Road Bed	0.383	Imperceptible
474*	Rahoon	Road	0.756	Road Bed	0.161	Imperceptible
478	Rahoon	Zoned Lands	0.853	Partial landtake and road bed	0.453	Slight
480 *	Rahoon	Zoned Lands	9.609	Partial landtake and road bed	1.302	Imperceptible
484 *	Letteragh / Rahoon	Zoned Lands	8.484	Partial landtake	1.304	Moderate
487	Bushypark / Ballagh	Church	0.801	Road Bed	0.044	Imperceptible

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
488 *	Bushypark	Zoned Lands	0.396	Partial Landtake	0.141	Slight
500	Menlough	Zoned Lands	6.592	Partial Landtake	0.911	Moderate
501	Barnacranny / Ballagh) / Letteragh	Zoned Lands and road	6.314	Road Bed	3.530	Imperceptible
528_543	Dangan Lower / Rahoon / Dangan Upper	NUIG Sporting Campus Zoned Lands -Recreational and Amenity	95.896	Partial landtake including removal of pitches and the partial demolition of the existing Sports Pavilion	6.293	Very Significant
516	Dangan Upper	Zoned Lands	0.310	Full landtake	0.310	Moderate
517	Dangan Upper / Dangan Lower	Road	0.529	Road Bed	0.364	Imperceptible
513 *	Dangan Upper / Barnacranny	Zoned Lands	3.631	Partial landtake	1.454	Moderate
521	Dangan Upper	Zoned Lands	0.310	Full landtake	0.310	Moderate
522	Dangan Upper	Zoned Lands	0.232	Partial landtake	0.114	Slight
526	Dangan Lower	Zoned Lands	0.237	Partial landtake	0.061	Slight
531	Dangan Lower	Road	0.674	Road Bed	0.426	Imperceptible
542	Dangan Lower	Road	0.093	Road Bed	0.088	Imperceptible
556	Menlough	Zoned Lands	0.375	Road Bed	0.007	Imperceptible
561	Menlough	Zoned Lands	0.593	Road Bed	0.413	Imperceptible
511	Dangan Upper	Road	0.898	Road Bed	0.532	Imperceptible
574	Menlough / Ballybrit	Road	0.343	Road Bed	0.211	Imperceptible
590	Menlough	Road	0.01	Road Bed	0.01	Imperceptible

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
593	Menlough	Road	0.018	Road Bed	0.005	Imperceptible
596	Coolagh	Church	0.054	Road Bed	0.010	Imperceptible
595	Coolagh	Road	0.079	Road Bed	0.047	Imperceptible
584	Coolagh	Road	0.319	Partial landtake	0.002	Imperceptible
586 *	Doughiska / Castlegar / Ballybrit / Ballindooley	Zoned Lands	4.890	Partial landtake and road bed	0.881	Slight
624 *	Castlegar / Ballindooley	Zoned Lands	7.549	Partial landtake	3.121	Slight
650	Castlegar	Primary School	0.563	Partial landtake from School lands and road bed	0.077	Slight
661*	Castlegar / Parkmore	Zoned lands	0.396	Partial landtake and road bed	0.059	slight
660 *	Castlegar / Parkmore	Zoned Lands	1.449	Partial landtake and road bed	0.142	Slight
665	Castlegar / Parkmore	Road	0.318	Road bed	0.007	Imperceptible
669	Castlegar	Zoned Lands	0.322	Road bed	0.009	Imperceptible
688*	Parkmore / Polkeen	Zoned Lands	6.632	Partial landtake	4.103	Significant
702	Parkmore / Castlegar	Zoned Lands	0.1422	Partial landtake	0.141	Significant
703	Doughiska	Zoned Lands	0.913	Partial landtake	0.014	Imperceptible
710	Ballybrit	Zoned Lands	0.253	Partial landtake	0.165	Significant
724 * (**)	Coolagh/ Doughiska/	Two houses and garden and Zoned Lands	4.074	Partial landtake	2.717	Significant
732*	Coolagh	Zoned Lands	5.261	Partial landtake	0.106	Slight
733	Ballybrit	Zoned Lands	0.105	Partial landtake	0.001	Imperceptible

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
750*	Coolagh	Zoned Lands	5.861	Partial landtake	1.994	Moderate
751	Coolagh / Doughiska	Zoned Lands	21.659	Partial landtake	8.178	Significant
752	Coolagh / Doughiska	Zoned Lands	14.024	Partial landtake	1.089	Slight
754	Doughiska	Zoned Lands	4.952	Partial landtake	1.398	Moderate
756	Coolagh)	Zoned Lands	0.202	Partial landtake	0.030	Slight
758	Coolagh	Zoned Lands	6.259	Partial landtake and road bed	2.458	Significant
760	Doughiska	Zoned Lands	12.407	Road Bed	0.511	Imperceptible
761	Doughiska	Zoned Lands	1.635	Partial landtake	0.049	Imperceptible
762	Doughiska	Zoned Lands	5.038	Partial landtake	0.076	Slight
763	Doughiska	Zoned Lands	0.001	Partial landtake	0.001	Imperceptible
670	Parkmore / Castlegar	Road	0.196	Road Bed	0.197	Imperceptible
728	Ballybrit	Road	0.050	Road Bed	0.044	Imperceptible
696 *	Ballybaan Beg/ Parkmore / Ballybrit / Polkeen / Brockagh	Zoned Lands	38.541	Partial landtake and road bed	3.190	Imperceptible
691	Ballybrit / Parkmore	Racecourse	60.159	Partial landtake of paved areas and acquisition of stables	5.104	Very Significant
545	Dangan Lower/ Menlough	River Bed	0.252	River Bed	0.252	Imperceptible
557	Coolagh	River Bed	0.266	River Bed	0.266	Imperceptible
706	Doughiska / Breanloughaun / Coolagh / Bushypark / Ballagh / Dangan Lower / Dangan	Road	46.491	Partial landtake and road bed	18.843	Imperceptible

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
	Upper / Castlegar / Parkmore / Garraun North					
765	Rahoon / Menlough / Coolagh	Road	37.885	Road Bed	1.1911	Imperceptible
689 *	Parkmore	Zoned Lands	8.756	Full landtake	8.756	Moderate
668 *	Parkmore / Castlegar	Zoned Lands	6.839	Partial landtake and road bed	0.939	Moderate
659 *	Castlegar / Parkmore	Zoned Lands	2.404	Full landtake	2.404	Moderate
690 *	Parkmore	Zoned Lands	7.406	Partial landtake	5.726	Moderate
692 *	Parkmore	Zoned Lands	0.356	Full landtake	0.356	Moderate
712 *	Ballybrit	Zoned Lands	0.016	Full landtake	0.016	Moderate
709 *	Ballybrit	Zoned Lands	0.461	Full landtake	0.461	Moderate
722 *	Doughiska	Zoned Lands	0.655	Full landtake	0.655	Moderate
757 *	Coolagh	Zoned Lands	4.287	Partial landtake	0.225	Moderate
223 *	Mincloon, Clybaun, Keeraun, Cappagh, Ballynahown East	Zoned Lands	15.922	Partial landtake and road bed	3.320	Slight
481 **	Rahoon	Zoned Lands	3.050	Partial landtake	0.599	Slight
597 **	Coolagh	Zoned Lands	3.500	Partial landtake and road bed	0.025	Imperceptible
586 *	Ballybrit, Doughiska, Castlegar, Ballindooley	Zoned Lands	8.650	Partial landtake and road bed	2.387	Slight
690 **	Parkmore	Zoned Lands	7.406	Partial landtake	5.725	Significant
694 **	Parkmore	Zoned Lands	2.799	Partial landtake	0.619	Slight
693**	Parkmore	Zoned Lands	2.853	Partial landtake	0.708	Slight

Protected Road Order / Motorway Order Number	Townland	Description	Area of Property (Ha)	Nature of Impact		Level of Impact
				Description of Landtake	Land to be Acquired (ha)	
731 **	Ballybrit	Zoned Lands	0.523	Partial landtake	0.022	Slight
730 **	Ballybrit	Zoned Lands	0.397	Partial landtake	0.033	Slight
718 **	Ballybrit	Zoned Lands	0.685	Partial landtake	0.253	Slight

Note:

** this property is also dealt with in **Chapter 14, Material Assets Agriculture** as the property is part of an agricultural property and areas quotes include agricultural lands*

*** property also included in **Table 15.4***

15.5.2.5 Planning Permissions affected by the proposed road development

The proposed road development will require the acquisition of lands from five properties upon which there is currently full planning permission for residential or commercial development. These acquisitions will result in either the revocation or the need for modification of the planning permission. These are listed below in **Table 15.8** and are shown in **Figures 14.1.1** to **14.1.14**.

Table 15.8: Planning Permissions affected by the proposed road development

PRO / MO No.	Townland	Description	Area of property (Ha)	Nature of Impact		Level of Impact	Revoke or modify
				Description of Landtake	Land to be acquired (Ha)		
124*	Na Foraí Maola Thiar	Full residential planning permission	0.470	Acquisition of whole site	0.470	Moderate	Revoke
149	Troscaigh Thiar	Planning permission for roadside boundary wall and existing access point as constructed with all associated works and ancillary services.	0.200	Boundary Wall relocation, Road Bed acquisition	0.0075	Imperceptible	Modify
229	Ballyburke	Planning permission granted for the demolition of two existing houses shed and outbuildings, construction of crèche, 3 no retail units, 3 no office units, bar/restaurant and 299 residential units in varying design and form, in two and three storey blocks, bin storage, ESB substation, surface and basement car parking and all associated external and site development works including 3 vehicular access points and road widening along Ballymoneen Rd. (1454) (Extension of time to 18/07/2019)	9.2	Severance of site	1.45	Moderate	Modify
528_543	Dangan Lower	Permission for new all-weather sports pitch on the site of existing training pitch (including floodlighting)(14104)	95.896	Partial acquisition of property	6.293	Very Significant	Revoke
528_543	Dangan Lower	Permission for flood lighting of existing GAA pitches adjacent to the river. (17159)	95.896	Partial acquisition of property	6.293	Very Significant	Revoke

*Note: * Lands also included in **Table 15.4**. above*

15.5.2.6 Potential impacts on Material Assets Non-Agricultural - Services

Electricity services, gas services, telecommunication services, water supply and foul water services will each be affected by the proposed road development as outlined below in this section.

Electrical Services

The proposed road development will require the localised diversion and/or modification of the existing 38kV and 110kV networks as follows:

- 110kV network to be diverted at 3 locations
- 38kV network to be diverted at 9 locations

Conflicts[5] with the existing 110kV network have been discussed ESB Networks, the Transmission System Owner, and EirGrid, the Transmission System Operator. The 110kV network comprises overhead conductors, supported on double-wood polesets along straights, with lattice steel structures (known as ‘‘angle towers’’) where the circuit alignment changes direction. Where resolution is necessary it is proposed by way of localised diversion, or by a generally modest raising of existing polesets/towers in immediate proximity to the proposed road development in order to ensure adequate separation distance between the overhead conductors and ground levels (known as ‘‘vertical clearance’’). At some locations the existing towers can be retained at their current location and the proposed road development will pass underneath. Where adequate vertical clearance is available no works will be required. In instances of inadequate vertical clearance the line will need to be raised between towers allowing for sag of the line due to ‘its loading” - the amount of power it carries – as well as for seasonal weather conditions, especially ice. Each diversion has been assessed from both a construction point of view, but also from an operational point of view to ensure the continued operation of the electrical grids while constructing the proposed road development. The alternative of localised undergrounding of all of the existing 110kV overhead lines as part of the diversion works was considered by this working group; however due to the conflict locations and the necessity to underground the line back to a substation and the proximity to such a substation it was agreed by ESB Networks and EirGrid not to be feasible, nor indeed necessary and/or appropriate, given that it would have a potentially significant adverse impact upon the safe, secure and reliable operation of the grid, by introducing significant complexity into the system.

The diversion locations are listed in **Table 15.9**, and shown in **Figures 15.1.1** to **15.1.15**. Once these diversions are complete the powerlines will operate in the same way as they currently do. However, there is a temporary impact to the service to complete these diversions. These impacts include a power outage of the line which can only be completed during the outage season (generally April-October when demand for electricity is generally lower in comparison with the winter period), and

[5] The technical term for the intrusion of a planned development with an existing circuit is a ‘conflict’. This simply means something that needs to be resolved, rather than in its more literal sense. ESB Networks have a dedicated Conflicts Section, and the resolution of ‘conflicts’ is an established practice, occurring by way of localised re-design or diversion.

switching of power onto other circuits during that time. All of this requires a phased and careful planned approach to the development of different circuits, the outage season, the phasing of the transmission development in advance of main construction, and protection of the circuits during the construction. This is undertaken exclusively by EirGrid and ESBN as Transmission System Operator (TSO) and Distribution System Operator (DSO)respectively, and is not within the power of the Applicant to control or undertake. As such these potential impacts are ranked as Moderate, albeit temporary, and strictly controlled to ensure no loss of supply to customers and the general public.

There will also be a requirement to protect in-situ[6] the 38kV and 110kV services as follows:

- 110kV service to be protected in-situ at 5 locations
- 38kV services to be protected in-situ at 14 locations

These potential impacts are ranked as Not Significant.

The lower voltage ESB powerlines will require diversion at 36 locations. These potential impacts are ranked as Slight.

There is also a requirement to protect in-situ the lower voltage ESB powerlines at 63 locations. These potential impacts are ranked as Not Significant as there will be no consequences to this service as a result of these measures.

The underground 110kV line is in conflict with the proposed road development in four locations however this service will be protected in-situ and no diversion works are required. These potential impacts are ranked as Not Significant as there will be no consequences to this service as a result of these measures.

Table 15.9: Electrical Services affected or in conflict with the Proposed Road Development

Approx. Chainage	Townland	Description	Affected Lengths (m)	Level of Impact	Proposed Mitigation
Ch. 6+300	Rahoon	ESB 38kV Underground Service	167m	Moderate	Divert as shown on **Figure 15.1.04** as agreed with ESB
Ch. 6+675	Rahoon	ESB 38kV Overhead Service	76m	Moderate	Divert as shown on **Figure 15.1.04** as agreed with ESB
Ch. 8+270 to 8+400	Barnacranny	ESB 38kV Overhead Service	127m	Moderate	Divert as shown on **Figure 15.4.05** as

[6] The existing infrastructure will be maintained in its current location and protected during construction by the use of 'goal posts' and fencing for the overhead powerlines and utilising a protection layer over the underground cable circuit. All works will be undertaken in accordance with the safe working guidelines as outline in ESB Networks "Safe Construction with Electricity").

Approx. Chainage	Townland	Description	Affected Lengths (m)	Level of Impact	Proposed Mitigation
					agreed with ESB
Ch. 8+400 to 600	Dangan	ESB 38kV Overhead Service	285m	Moderate	Divert as shown on **Figure 15.1.05** as agreed with ESB
Ch. 8+600	Dangan	ESB 38kV Overhead Service	20m	Moderate	Divert as shown on **Figure 15.1.05** as agreed with ESB
Ch. 13+525	Castlegar	ESB 38kV Overhead Service	111m	Moderate	Divert as shown on **Figure 15.1.08** as agreed with ESB
Ch. 14+375 (Parkmore Link Road)	Ballybrit / Parkmore	ESBI 110kV Overhead Service	1040m	Moderate	Divert as shown on **Figure 15.1.09** and **15.1.14** as agreed with ESBI
Ch. 14+425 (Parkmore Link Road)	Ballybrit / Parkmore	ESBI 38kV Overhead Service	317m	Moderate	Divert as shown on **Figure 15.1.09** and **15.1.14** as agreed with ESBI
Ch. 16+260 to 16+800	Coolagh	ESB 38kV Overhead Service	1065m	Moderate	Divert as shown on **Figure 15.1.10** as agreed with ESB
Ch. 16+260 to 16+800	Coolagh	ESBI 110kV Overhead Service	648m	Moderate	Divert as shown on **Figure 15.1.10** as agreed with ESBI
Ch. 16+260 to 16+800	Coolagh	ESBI 110kV Overhead Service	641m	Moderate	Divert as shown on **Figure 15.1.10** as agreed with ESBI
N59 Link Road South	Rahoon	ESB 38kV Underground Service	33m	Moderate	Divert as shown on **Figure 15.1.12** as agreed with ESB

Gas Services

The proposed road development will require the localised diversion and/or modification of the existing of Gas Networks Ireland (GNI) services at two locations as shown on **Figures 15.2.1** to **15.2.5** and listed in **Table 15.10** below. Once these diversions are complete the gas network will operate in the same way as they currently do. However, there is an impact to the service to complete these diversions. These impacts include an outage of the line which requires a phased and careful planned approach to the development in advance of main construction and protection of the network during the construction. As such these potential impacts are ranked as Moderate.

There is also a requirement to protect in-situ Gas Networks Ireland (GNI) services at nine locations. These potential impacts are ranked as Not Significant as there will be no consequences to this service as a result of these measures.

Table 15.10: GNI Services affected or in conflict with the Proposed Road Development

Approx. Chainage	Townland	Description	Affected Lengths (m)	Level of Impact	Proposed Mitigation
Ch. 6+520 (N59 Link Road South/Rahoon Road JNC)	Rahoon	Gas – Distribution network	95m	Moderate	Divert as shown on **Figure 15.2.01** as agreed with GNI
Ch. 13+150	Castlegar	Gas – Transmission network	115m	Moderate	Divert as shown on **Figure 15.2.03** as agreed with GNI

Telecommunications

There are a number of telecommunication services crossed by the proposed road development, including Eir, Virgin Media, E-Net, BT and Vodafone. New ducting will be provided in the verges of the proposed road development for future use resulting in a positive Moderate impact.

<u>Eir</u>

The proposed road development will require the localised diversion and/or modification of the existing of Eir services at 17 locations as follows:

- Ch. 0+000
- Ch. 2+840
- Ch. 2+845
- Ch. 3+325
- Ch. 3+550
- Ch. 5+620
- Ch. 6+300

- Ch. 6+300 to 6+450
- Ch. 7+250
- Ch. 8+550
- Ch. 10+100
- Ch. 12+120
- Ch. 13+170
- Ch. 15+045
- Ch. 15+700
- Ch. 15+870
- Ch. 16+250

These potential impacts are considered to be a Slight impact.

There is also a requirement to protect in-situ Eir services at 31 locations. These potential impacts are ranked as Not Significant.

<u>Virgin Media</u>

Virgin Media have a number of underground fibre optic cables running in ducting along existing roads crossed by the proposed road development. The proposed road development will require the localised diversion and/or modification of the existing of Virgin Media services at two locations as follows:

- Ch. 7+280
- Ch. 7+285

These potential impacts are considered to be a Slight impact.

There is also a requirement to protect in-situ Virgin Media services at six locations. These potential impacts are ranked as Not Significant.

<u>E-Net</u>

E-Net have a number of fibre optic cables running in ducting along existing roads crossed by the proposed road development.

The proposed road development will require the localised diversion and/or modification of the existing of E-Net fibre optic at five locations as follows:

- Ch. 13+700
- Ch. 15+050
- Ch. 15+730
- Ch. 15+880
- Ch. 16+350

These potential impacts are considered to be a Slight impact.

There is also a requirement to protect in-situ E-Net fibre optic at 14 locations. These potential impacts are ranked as Not Significant.

BT Ireland

BT Ireland have a number of underground fibre optic cables running in ducting along existing roads crossed by the proposed road development.

The proposed road development will require the localised diversion and/or modification of the existing of BT Ireland optic at one location as follows:

- Ch. 16+300

This potential impact is considered to be a Slight impact.

There is also a requirement to protect in-situ BT Ireland at five locations. These potential impacts are ranked as Not Significant.

Vodafone

The proposed road development will require the full acquisition of a telecommunications mast at Ch. 4+650 which is operated by Vodafone. This mast has planning permission until 2020 at which time planning permission maybe renewed or the mast decommissioned.

Three Networks Ireland

Three Networks Ireland operate a telecommunications mast at Ch. 14+500 which will be decommissioned for the construction of the proposed road development and relocated.

Water Supply and Foul Water Services

The proposed road development is in conflict with a number of water services (watermains, foul and surface water sewers) within the study area. The conflicts that require diversion works are listed in **Table 15.11** below along with the level of impact.

There are no waste facilities potentially impacted by the proposed road development.

Table 15.11: Water Services affected or in conflict with the Proposed Road Development

Approx. Chainage	Townland	Description	Affected Lengths (m)	Level of Impact	Proposed Mitigation
Ch. 0+000	Na Foraí Maola	150mm Ø Watermain	125m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 1+570	Troscaigh	80mm Ø Watermain	40m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council

Approx. Chainage	Townland	Description	Affected Lengths (m)	Level of Impact	Proposed Mitigation
Ch. 2+760	Troscaigh	100mm Ø Watermain	155m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 3+250	An Chloch Scoilte	80mm Ø Watermain	130m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 4+450	Cappagh	150mm Ø Watermain	107m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 5+650	Ballyburke	250mm Ø Watermain	195m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 6+150	Knocknacarra	150mm Ø Watermain	100m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 6+150	Knocknacarra	150mm Ø Watermain	280m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 6+280	Rahoon	250mm Ø Watermain	147m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 6+300	Rahoon	250mm Ø Watermain	180m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 6+200	Knocknacarra	150mm Ø Watermain	45m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 6+600	Rahoon	250mm Ø Watermain	97m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 7+220	Letteragh	250mm Ø Watermain	275m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 7+230	Letteragh	300mm Ø Watermain	340m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 7+250	Letteragh	150mm Ø Watermain	525m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 7+250	Letteragh	150mm Ø Watermain	80m	Slight	Divert in agreement with Irish Water / Galway City

Approx. Chainage	Townland	Description	Affected Lengths (m)	Level of Impact	Proposed Mitigation
					Council / Galway County Council
Ch. 7+400	Letteragh	300mm Ø Watermain	50m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 7+250	Letteragh	Proposed 80mm Ø Watermain	606m	Slight	Install in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 8+250	Bushypark	100mm Ø Watermain	128m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 8+300	Bushypark	100mm Ø Watermain	122m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 8+400	Dangan	25mm Ø Watermain	170m	Slight	Divert in agreement with Irish Water/ Galway City Council/ Galway County Council
Ch. 8+520	Dangan	100mm Ø Watermain	95m	Slight	Divert in agreement with Irish Water/ Galway City Council/ Galway County Council
Ch. 11+390	Coolagh	Proposed 100mm Ø Watermain	1062m	Slight	Install in agreement with Irish Water/ Galway City Council/ Galway County Council
Ch. 13+130	Castlegar	100mm Ø Watermain	305m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 13+870	Twomileditch	250mm Ø (10 inch) Watermain	213m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 13+880	Twomileditch	500mm Ø Watermain	590m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 15+000	Ballybrit	100mm Ø Watermain	318m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 15+200	Ballybrit	250mm Ø Watermain	97m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 16+450	Doughiska	150mm Ø Watermain	123m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council

Approx. Chainage	Townland	Description	Affected Lengths (m)	Level of Impact	Proposed Mitigation
Ch. 5+950	Ballyburke	300mm Ø Foul Sewer	225m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 13+200	Castlegar	225mm Ø Foul Sewer	325m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 13+650	Twomileditch	300mm Ø Foul Sewer	165m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 15+280	Ballybrit	375mm Ø Foul Sewer	95m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 16+500	Doughiska	225mm Ø Foul Sewer	135m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 5+850	Ballyburke	300mm Ø Surface Water Sewer	223m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 13+650	Twomileditch	900mm Ø Surface Water Sewer	170m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 15+280	Ballybrit	600mm Ø Surface Water Sewer	335m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council
Ch. 16+500	Doughiska	225mm Ø Surface Water Sewer	142m	Slight	Divert in agreement with Irish Water / Galway City Council / Galway County Council

15.5.3 Potential Operational Impacts

Once the proposed road development will be operational, all properties with the exception of NUIG Sports Pavilion will have access and utilities will operate and function to a level of service as is the current situation. The NUIG Sports Pavilion will have restricted access to its western perimeter, due to the presence of the proposed road development.

Through traffic on the Parkmore Link Road will introduce a delay to the movement of product and people within the Boston Scientific campus. However, the proposed link road will be at-grade and, while assessed as a moderate impact, any delay to movement will not be long enough to amount to a significant impact.

Galway Racecourse will continue to operate and function to a level of service as is the current situation.

15.6 Mitigation Measures

15.6.1 Introduction

This section outlines the proposed mitigation measures for material assets non-agriculture.

15.6.2 Construction Phase

In the event of an approval of the Protected Road Scheme and Motorway Scheme and approval under Section 51 of the Roads Act 1993 (as amended), by An Bord Pleanála and subject to the availability of funding, Notice to Treat will be served firstly on owners, lessees and occupiers of the dwelling houses and commercial properties to be acquired, within six months of the scheme becoming operative, unless an application has been made for Judicial Review, in which case the Notice to Treat[7] will be served in accordance with the provisions of Section 217 (6A) of the Planning and Development Act 2000 as inserted by the Compulsory Purchase Orders (Extension of Time Limits) Act 2010. Compensation will be agreed or determined by the property arbitrator as soon as possible after service of Notice to Treat. After compensation has been agreed or determined and satisfactory title has been produced, part payment can be made while the claimant remains for an agreed period in the property to be acquired. This will facilitate the claimant in removing uncertainty and will facilitate arrangements being made, as early as possible, to secure a replacement property.

Where existing access to property is affected, this will be reinstated or an alternative access provided.

Where part of a property or land surrounding a property is to be acquired, appropriate accesses have been designed and appropriate boundary treatment will be constructed.

The proposed road development severs the NUIG Sporting Campus facilities. During construction, restricted access across the construction area at the NUIG Sporting Campus facilities will be maintained.

Alternative pitch facilities will be provided to replace the existing pitches directly impacted by the proposed road development. The facilities include a floodlit 3G GAA pitch and a floodlit 3G training area and associated site infrastructure for the drainage of these pitches and furniture such as ball-stop netting. The proposed road development also intercepts the existing sports pavilion resulting in direct impacts to its western end and the building will be modified as follows:

- the existing western plant room, 1 no. changing room, 1 no. storage area, 1 no. weights area and associated access hallways on both ground floor and upper levels will be demolished

[7] This notice requests landowners to submit their claim for compensation for lands being taken under the Protected Road Scheme or Motorway Scheme. This is the initial step in the acquisition of property and lands.

- the western plant room and its associated plant will be relocated
- Construction and reconfiguration of the internal and external walls, roof, windows and door locations

During the construction of the River Corrib Bridge, alternative access to that along the bank of the River Corrib will be provided.

Temporary stables will be provided for Galway Racecourse during the construction of the proposed road development until such time as the Galway Racecourse Tunnel is complete and the permanent stables are constructed.

Mitigation measures as detailed in individual accommodation works agreements, such as boundary treatment, domestic entrances, property condition surveys (as outlined in **Chapter 17, Noise and Vibration**), provision of ducting to facilitate services, maintenance of access during construction amongst other items will remove impacts related to the properties with partial landtake. Compensatory measures for the loss of land, buildings and other injurious affection will form part of the land acquisition process and will be agreed at a later date with a valuer. Compensation does not form part of the EIA process and is therefore not considered further.

Each of the utility diversions associated with the proposed road development have been planned with ongoing and detailed engagement with relevant utility providers during the preparation of this EIA Report. This engagement will continue prior to and during the construction phases. Each diversion has been assessed from both a construction point of view, but also from an operational point of view.

Where the infrastructure for service providers is impacted, this will be diverted or reinstated in accordance with service providers' requirements prior to construction. Service users will be notified in advance of any temporary disruption or outages necessitated by the construction works. The disruption to services or outages will be carefully planned so the duration is minimised.

Public water supply and foul water systems affected will be reconnected. All necessary diversions will be carried out in accordance with the local authority and Irish Water's requirements. Where private potable water supplies are impacted, a new well or alternative water supply or financial compensation for the loss of the well will be provided.

Mitigation for interference with septic tanks will be agreed by the valuer at a later stage.

15.6.3 Operational Phase

The proposed road development will result in a 20 per cent reduction of the NUIG Sporting Campus at Dangan, due to the encumbrance caused by the viaduct support structures. This will result in the removal of two grass based GAA sized playing pitches.

As a consequence, the NUIG Sporting Campus will require a new Sporting Campus Plan and Strategy. The provision of a viaduct structure at the NUIG Sporting Campus will provide access to the north and south of the Sporting Campus and the

River Corrib during the operational phase, maintaining connectivity and permeability beneath the proposed road development.

The current road which provides access to Hewlett Packard and Boston Scientific will become a through road at the operational phase of the proposed road development. The additional traffic will present new severance compared with the Do-Nothing scenario. However, a speed of 50kph will limit speeds and traffic will be generally for local access only.

The stable yard and associated facilities for Galway Racecourse will be relocated as shown on **Figure 15.4.1** and detailed in **Appendix A.15.2**, mitigating the operational impacts on the racecourse.

Noise barriers will be provided across the length of the proposed road development to mitigate potential increase in noise as detailed in **Chapter 17, Noise and Vibration** and shown on **Figures 17.1.1** to **17.1.15**.

15.7 Residual Impacts

The residual impacts from all of the very significant/significant impacts, 54 residential properties, eight commercial properties and one residential planning permission, which will be acquired and/or demolished to accommodate the proposed road development, remain as very significant/significant impacts as no mitigation is possible to reduce the impact. The residual impact post compensation cannot be assessed as the compensation to be agreed as part of the land acquisition are outside the scope of the EIA process. Mitigation measures as detailed in individual accommodation works agreements will remove the residual impacts related to the properties with partial landtake.

There are no residual impacts on dwellings from which part of the road bed will be acquired. The residual landscape and visual impacts of diverting existing overhead powerlines are considered in **Chapter 12, Landscape and Visual**. There will be no residual impacts on services or services infrastructure.

The residual impacts on NUIG Sporting Campus remain as very significant in the absence of a new University Sports Masterplan. The proposed road development will effectively divide the Sports Campus into two, removing the two centrally located grass based sand carpet full sized GAA pitches. In tandem with this the existing context of the existing sporting changing facilities setting and curtilage will be altered completely. With an appropriate level of masterplanning and implementation of the following in such a masterplan would reduce the residual impact to moderate:

1. The sporting campus at Dangan will require a new sporting campus plan and strategy to re-accommodate the removed pitches and ancillary sports pavilion. This must be in line with the University’s overall strategic sport’s vision
2. The removal of the existing sports fields will require replacement by similar or more likely improved facilities which allow for the more intensive use of the remaining reduced campus footprint
3. Utilities, roads and access and egress routes around the campus will require complete re-planning to re-integrate with the proposed road development

4. The remaining sports pitches will require remodelling to accommodate a more intensive use of the existing campus footprint
5. The landscape setting of the existing campus will need to be developed to screen the visual effects of the proposed River Corrib Bridge from the surrounding pitches
6. Ancillary supporting facilities such as car parking and changing facilities will require remodelling

The residual impact on NUIG Sporting Campus post compensation cannot be assessed as the compensation to be agreed as part of the land acquisition is outside the scope of the EIA process.

There will be a positive residual impact on Galway Racecourse once the mitigation measures have been constructed with the provision of enhanced access to the premises and a new stable yard.

The residual impacts on Material Assets Non-Agriculture identified for the construction phase also apply for the operational phase.

15.7.1 Cumulative Impacts

Cumulative impacts are defined as the combination of many minor impacts creating one, larger, more significant impact (NRA, 2009 and EPA 2017). Cumulative impacts consider existing stresses on the natural environment as well as developments that are underway and in planning.

The cumulative impacts of the proposed road development on material assets non-agriculture with the following projects and plans have been assessed:

- M17 Galway to Tuam Road Project
- N18 Oranmore to Gort Road Project
- N17 Tuam Bypass
- M6 Motorway
- N59 Maam Cross to Oughterard Road Project
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project
- Galway Harbour Port Extension
- Galway Transport Strategy (GTS), which includes the following:
    - Investigate prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway
- Galway City Development Plan 2017 – 2023
- Galway County Development Plan 2015 – 2021

Although the proposed road development overlaps with other proposed projects such as the GTS measures which include the Tuam Road Bus Corridor and the

Galway to Oughterard Greenway, there are no cumulative impacts on Material Assets Non-Agriculture other than the potential impacts identified in **Section 15.5** above.

Similarly, the other proposed projects which have been identified will not result in any significant cumulative impact with the addition the proposed road development on Material Assets Non-Agriculture identified in the study area for the proposed road development.

15.8 Summary

The proposed road development will cross through lands populated by residential and commercial properties on the outskirts of Galway City and include both agriculture lands and lands zoned for development. The proposed road development has been designed to avoid as many properties as possible but given the built environment, and the linear type development of the city where housing is situated along every road radiating from the city, its construction will unfortunately and unavoidably result in a number of property demolitions.

Numerous alternatives have been considered as detailed in **Chapter 4, Alternatives Considered**, however the conclusion of the consideration of the alternatives is that the proposed road development represents the optimum solution and has avoided the greatest number of known and immovable constraints and is the option that overall has a lesser environmental impact taking all other potential environmental impacts into account.

Furthermore, the design of the emerging preferred route has been refined in as much as possible to eliminate and reduce impacts on the human environment. As discussed in **Chapter 4, Alternatives Considered**, significant design measures such as steeper earthwork slopes, steepened green embankments and retaining walls are employed in the scheme design to minimise the impact on the human environment. Additional mitigation measures such as noise barriers, landscaping, planting, earth bunding are also utilised to minimise the overall impact on the receiving environment as discussed in **Chapter 12, Landscape and Visual** and **Chapter 17, Noise and Vibration**.

The proposed road development is consistent with proper planning and sustainable development and this view is supported/validated by the inclusion of policy support for both GTS and constituent measures, including the proposed road development, in the relevant Galway Development Plans.

The proposed road development will acquire 184ha of land from 320 non-agricultural properties including residential, commercial, industrial properties and lands zoned for development, a sporting campus, racecourse, school lands and church lands. Included in this number is the acquisition of lands currently located within the public road in the registered ownership of private individuals. Road bed acquisition has an imperceptible impact on affected properties as works are entirely outside of the existing site boundary walls or fences.

It is proposed that there will be 54 residential properties fully acquired or demolished to facilitate the construction of the proposed road development. Of these 54 residential properties 10 require full acquisition while the remaining 44 will require demolition. Five commercial properties will be full acquired or demolished. Of these five commercial properties, one requires full acquisition and the remaining four will require demolition. One landholding that has a full residential planning permission will also require full acquisition.

Of the 320 non-agricultural properties, 31 of these properties will have very significant impacts, 28 significant impacts, 59 moderate, 103 slight, with the remaining 99 being imperceptible. There are no non-significant impacts resulting from the proposed road development.

The proposed road development will have very significant impacts on the NUIG Sporting Campus at Dangan in the absence of a new University Sports Masterplan.

The stable yard and associated facilities for Galway Racecourse will be relocated mitigating the potential operational impacts on the racecourse. There will be enhanced ingress and egress from the racecourse as a result of the proposed road development. Overall it is considered that the proposed road development will result in a slight positive residual impact on the racecourse.

The area is well serviced with utility networks including electricity, gas, telecommunications and water supplies. There are a number of conflicts with utility services and the proposed road development as follows:

- 8 conflicts with the 110kV ESB network
- 23 conflicts with the 38kV ESB network
- 99 conflicts with MV and LV ESB network
- 11 conflicts with Gas Networks Ireland services
- 48 conflicts with Eir services
- 8 conflicts with Virgin Media services
- 19 conflicts with E-Net services
- 6 conflicts with BT Ireland services
- 1 conflicts with Vodafone services
- 1 conflicts with Three Networks Ireland services
- 29 conflicts with watermain services
- 5 conflicts with foul sewer services
- 4 conflicts with surface water services

Of these conflicts, there are 14 moderate impacts on services which include the diversions associated with ESB (three 110kV diversions and nine 38kV diversions) and GNI services (two diversions).

Of the remaining conflicts, there are:

- 29 slight and 29 Not Significant impacts to ESB Low and Medium Voltage network

- 4 Not Significant impacts to ESB Networks (110kV underground line installed by SSE)
- 17 slight and 31 Not Significant impacts to EIR services
- 2 slight and 6 Not Significant impacts to Virgin Media services
- 5 slight and 14 Not Significant impacts to E-Net services
- 1 slight impact to Vodafone services
- 1 slight impact to Three Networks Ireland services
- 1 slight and 5 Not Significant impacts to BT services
- 29 slight impacts to Irish Water watermains
- 4 slight impacts to Irish Water public foul sewers
- 1 slight impact to an IDA private foul sewer
- 4 slight impacts to Galway City Council public surface water sewers

Where there is an impact on existing services during the construction phase an alternative supply will be made available. It will be necessary to maintain supply to existing services, as far as possible, during construction. There are no residual impacts on services.

There will be no cumulative impacts from the proposed road development on material assets non-agriculture with other projects and plans.

15.9 References

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Electronic Sources

www.landregistry.ie

16 Air Quality and Climate

16.1 Introduction

This chapter of the EIAR consists of an appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development under the heading of air quality and climate.

This chapter initially sets out the methodology followed (**Section 16.2**), describes the receiving environment (**Section 16.3**), and summarises the main characteristics of the proposed road development which are of relevance for air quality and climate (**Section 16.4**). The evaluation of impacts of the proposed road development on air quality and climate impacts are described (**Section 16.5**). Measures are proposed to mitigate these impacts (**Section 16.6**) and residual impacts are described (**Section 16.7**). The chapter concludes with a summary (**Section 16.8**) and reference section (**Section 16.9**).

This chapter has utilised the information gathered during the pre-application stage of the proposed road development to inform the air quality and climate impact appraisal. **Sections 4.4**, **6.5.9** and **7.6.9 of the Route Selection Report** considered the air quality and climate constraints within the scheme study area and compared the potential of air quality impacts of the proposed route options respectively. These assessments and sections of the Route Selection Report contributed to the design of the proposed road development which this chapter appraises.

16.2 Methodology

16.2.1 Introduction

This chapter is prepared having regard to the requirements of the Transport Infrastructure Ireland (TII, formerly National Roads Authority (NRA)) document *'Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes*', 2011.

The impact of the proposed road development on air quality is assessed for both the construction and operational phases by considering the pollutant background concentrations, emissions from road traffic, potential for construction dust and emissions from construction traffic. Predicted concentrations are compared to the relevant limit values.

Carbon emissions are considered in terms of Ireland's obligations to reduce its carbon emissions.

This chapter has also been prepared having regard to the following guidelines:

- Guidelines on the information to be contained in environmental impact assessment reports (EPA, Draft 2017)
- Revised Guidelines on the Information to be contained in Environmental Impact Statements (EPA, Draft 2015)

- Advice Notes for Preparing Environmental Impact Statements (EPA, draft 2015)
- Guidelines on the Information to be contained in Environmental Impact Statements (EPA 2002)
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA 2003)

16.2.2 Legislation and Guidelines

This section sets out the legislation and guidelines under the headings of:

- Air quality standards and limits
- Climate change obligations and policy
- Transport Infrastructure Ireland Guidance

16.2.2.1 Air Quality Standards and Limits

In order to reduce the risk of poor air quality, national and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values are set for the protection of human health and ecosystems.

On 12 April 2011, the Air Quality Standards Regulations (AQS) 2011 (S.I. No. 180 of 2011) came into force and transposed EU Directive 2008/50/EC on ambient air quality and cleaner air for Europe (the Air Quality Directive) into Irish law. The purpose of the 2011 Regulations is to establish limit values and alert thresholds for concentrations of certain pollutants, to provide for the assessment of certain pollutants using methods and criteria common to other European Member States, to ensure that adequate information on certain pollutant concentrations is obtained and made publicly available and to provide for the maintenance and improvement of ambient air quality where necessary. These standards were introduced to avoid, prevent or reduce harmful effects on human health and the environment as a whole.

The limit values established under these regulations relevant to the assessment of road schemes are included in **Table 16.1**.

Table 16.1: Air Quality Standards (AQS) from Regulations 2011 (S.I No. 180 of 2011)

Pollutant	Limit value for the protection of:	Averaging period	Limit value ($\mu g/m^3$)	Basis of application of limit value	Limit value attainment date
NO_2	Human Health	1-hour	200	≤18 exceedances p.a. (99.79 % ie)	1 January 2010
		Calendar year	40	Annual mean	1 January 2010
NO_x	Vegetation	Calendar year	30	Annual mean	1 January 2010
PM_{10}	Human Health	24-hours	50	≤35 exceedances p.a. (98.1%ile)	1 January 2005
		Calendar year	40	Annual mean	1 January 2005
$PM_{2.5}$	Human Health	Calendar year	20	Annual mean	1 January 2020

Pollutant	Limit value for the protection of:	Averaging period	Limit value ($\mu g/m^3$)	Basis of application of limit value	Limit value attainment date
CO	Human Health	8-hour Annual Average	10,000	8-hour Average	1 January 2005
Benzene	Human Health	Calendar year	5	Annual mean	1 January 2010

According to the *UK Design Manual for Roads and Bridges (DMRB, Volume 11, Section 3, Annex F, 2007*) (hereafter referred to as DMRB) road transport represents a negligible source (less than 1%) of UK sulphur dioxide emissions. Concentrations may have been slightly elevated at heavily trafficked roadside locations in the past, but because the maximum permitted sulphur content of road fuels has periodically been reduced, the contribution is now much lower. On this basis, sulphur dioxide is not considered further.

The TII guidelines state that air quality and climate predictions should be carried out using the screening model method described in the DMRB.

The WHO *Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide, Global update 2005* provide limit values for those pollutants. **Table 16.2** outlines those guidelines for PM_{10}, (particles of 10 microns or more) $PM_{2.5}$ (particles of 2.5 microns or more) and nitrogen dioxide.

Table 16.2: WHO Air quality guidelines

Pollutant	Averaging period	Limit value ($\mu g/m^3$)
NO_2	Annual mean	40
	1-hour mean	200
PM_{10}	24-hour (99 percentile)	50
	Annual mean	20
$PM_{2.5}$	24-hour (99 percentile)	25
	Annual mean	10

The guidelines for NO_2 are the same as the air quality standards. Guidelines for PM_{10} and $PM_{2.5}$ are substantially lower than the standards. As the air quality standards are the statutory limits that apply in Ireland, baseline and predicted values are compared to these levels. However, an assessment of compliance with the WHO guideline values is also included for completeness.

Ultrafine particles (UFP) are the smallest constituents of airborne particulate matter at less than 0.1 micrometres. UFP can be inhaled more deeply into the lungs than larger particles, and are likely to have adverse health effects. However, as yet, no air quality standard has been set by the EU as further monitoring and assessment of potential effects is ongoing. The WHO concluded that while there is considerable toxicological evidence of potential detrimental effects of ultrafine particles on human health, the existing body of epidemiological evidence is insufficient to reach a conclusion on the exposure response relationship of ultrafine particles (WHO Air quality guidelines, 2005).

There are no national or EU limits for dust deposition. However, the *Technical Instructions on Air Quality Control* (TA Luft, 2002) provide a guideline for the rate of dust deposition of 350 mg/m^2/day averaged over one year.

The Environmental Protection Agency (EPA) concurs that this guideline may be applied, although applied as a 30-day average, in its document *Environmental Management in the Extractive* Industry (Non-Scheduled Minerals) (EPA, 2006).

Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, was published in December 2016. The directive specifies reductions for nitrogen oxides, particulate matter and non-methane Volatile Organic Compounds (NMVOC) for the period from 2020 to 2019 and from 2030 onward compared with 2005 levels. The limits that apply to Ireland are outlined in **Table 16.3**.

Table 16.3: Directive (EU) 2016/2284 emission limits

Pollutant	Reduction compared with 2005 in 2020-2029 (%)	Reduction compared with 2005 in 2020-2029 (kilotonnes)[1]	Reduction compared with 2005 in 2030 (%)	Reduction compared with 2005 in 2030 (kilotonnes) [1]
Nitrogen oxides	49	61.9	69	87.2
Particulate matter	18	n/a	41	n/a
NMVOC	25	14.7	32	18.8

[1] Based on the following 2005 values: nitrogen oxides-126.4kt, NMVOC- 58.8kt, no PM data available

The impact of nitrogen deposition is also considered in the assessment at ecologically sensitive areas. The TII Guidelines quotes the United Nations Economic Commission for Europe (UNECE) Critical Loads[1]for Nitrogen. As the Lough Corrib candidate, Special Area of Conservation (cSAC) is designated for the protection of a multitude of habitats including, hard water lakes, floating river vegetation, raised bogs, alkaline fens, bog woodland, a number of UNECE Critical Loads could be selected for assessment. The most stringent of these is for inland and surface water habitats (5-10kg(N)/ha/yr) and therefore, this is used in this assessment in **Section 16.5.4.2**. Critical levels[2] are also included in this assessment

1 Critical Loads are defined as: " a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"

(Source: http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm)

2 Critical levels are defined as "concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge".

(Source: http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm) for various relevant pollutants. These are not habitat specific, as in critical loads, but are set to cover broad vegetation types. They are defined as pollutant concentrations, as opposed to deposition values for critical loads.

16.2.2.2 Climate change obligations and policy

Ireland's climate obligations

In December 2008, the European Union (EU) Climate Change and Renewable Energy Package set out a number of commitments. This package commits to reduce the EU's Greenhouse Gas (GHG) emissions from non-Emission Trading Scheme (ETS) sectors (such as transport, agriculture, residential and waste) by 20% on 2005 levels by 2020 or by a more ambitious 30% in the event of a comprehensive global agreement.

As part of the effort-sharing proposal of this package, Ireland is one of the countries facing the highest target of a 20% reduction on 2005 levels for non-ETS sectors. This will result in a limit of approximately 38 million tonnes of carbon dioxide equivalent (Mt CO_2 eq) for Ireland's non-ETS emissions in 2020, together with annual binding limits for each year from 2013 to 2020.

In October 2014, EU leaders agreed a 2030 policy framework to reduce greenhouse gas emissions by at least 40% compared to a 1990 baseline. No agreement on the contribution of individual EU Member states has yet been reached.

National Policy on Climate Action

The Climate Action and Low-Carbon Development National Policy Position for Ireland was published in 2014. The Position provides a high-level policy direction for the adoption and implementation by Government of plans to enable the State to move to a low carbon economy by 2050.

The Climate Action and Low Carbon Development Act was published by government in January 2015. The Act sets out the national objective of transitioning to a low carbon, climate resilient and environmentally sustainable economy in the period up to 2050. The act provides for the preparation of National Mitigation Plans and Sectoral Plans which will specify policies to reduce greenhouse gas emissions for each sector, including transport. The first National Mitigation Plan was published in July 2017 by the Department of Communications, Climate Action and Environment. The Plan is designed to be a whole-of-Government approach to tackling greenhouse gas emissions, particularly, in the key sectors i.e. electricity generation, the built environment, transport and agriculture.

Climate Action and Transport Sector

In 2013, an Issues Paper for Consultation on the Preparation of Low-Carbon Roadmap for Transport was prepared by the Department of Transport, Tourism and

Sport. This paper proposed the following relevant policy measures to contribute to a low carbon future:

- Engines and fuels (efficiencies and alternatives)
- Travel demand
- Modal shift

The document Smarter Travel - A Sustainable Transport Future, A New Transport Policy for Ireland 2009 – 2020 includes a number of targets to reduce carbon emissions:

- Work-related commuting by car will be reduced from a current modal share of 65% to 45%, which will mean that between 500,000 and 600,000 commuters will be encouraged to take means of transport other than car driver (of these 200,000 would be existing car drivers)
- Car drivers will be accommodated on other modes such as walking, cycling, public transport and car sharing (to the extent that commuting by these modes will rise to 55% by 2020) or through other measures such as e-working
- The road freight sector will become more energy efficient, with a subsequent reduction in emissions
- Transport will make a meaningful contribution to Ireland’s commitment under the proposed EU effort-sharing arrangement in relation to climate change and real reductions on current levels of emissions will be achieved

Policies to reduce transport emissions include the reduction of travel demand, increase use of alternatives to the private car and improve the efficiency of motorised transport.

Ireland’s first National Climate Change Adaptation Framework (NCCAF), which was published in December 2012 by the Department of Environment, Community and Local Government, aims to ensure that adaptation actions are taken across key sectors and also at local level to reduce Ireland's vulnerability to climate change. This Framework is currently under review. Climate change adaptation measures have been considered through the provision of attenuation storage to accommodate the 100-year storm event with climate change, refer to **Chapter 11, Hydrology**.

16.2.2.3 Transport Infrastructure Ireland Guidelines

Operational Criteria

The TII Guidelines specifies that the changes in pollutant concentrations alongside roads with a significant change in traffic should be determined. It states that receptors should be considered at all road links where a greater than 5% change in Annual Average Daily Traffic (AADT) is predicted for the “Do-Something” option during the operational phase and during the construction phase where an increase of AADT greater than 10% is predicted.

Significance criteria have been adopted from the TII guidelines, these are presented in **Tables 16.4**, **16.5** and **16.6**.

Table 16.4: Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations

Magnitude of Change	Annual Mean NO2/PM10	No. days with PM10 concentration greater than 50 ug/m3	Annual Mean PM2.5
Large	Increase/decrease ≥ 4µg/m^3	Increase/decrease >4 days	Increase/decrease ≥2.5 µg/m^3
Medium	Increase/decrease 2-<4µg/m^3	Increase/decrease 3 or 4 days	Increase/decrease 1.25 -<2.5µg/m^3
Small	Increase/decrease 0.4-<2µg/m^3	Increase/decrease 1 or 2 days	Increase/decrease 0.25-<1.25µg/m^3
Imperceptible	Increase/decrease <0.4µg/m^3	Increase/decrease <1day	Increase/decrease <0.25µg/m^3

Table 16.5: Air Quality Impact Descriptors for Changes to Annual Mean Nitrogen Dioxide and PM_{10} and $PM_{2.5}$ Concentrations at a Receptor

Absolute Concentration in Relation to Objective/Limit Value	Change in Concentration[3]		
	Small	**Medium**	**Large**
Increase with Proposed Road Development			
Above Objective/Limit Value With Proposed Road Development (≥40 µg/m^3 of NO_2 or PM_{10}) (≥25µg/m^3 of $PM_{2.5}$)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value With Proposed Road Development (36≤40 µg/m^3 of NO_2 or PM_{10}) (22.5≤25µg/m^3 of $PM_{2.5}$)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value With Proposed Road Development (30≤36 µg/m^3 of NO_2 or PM_{10}) (18.75≤22.5 µg/m^3 of $PM_{2.5}$)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective/Limit Value With Proposed Road Development (<30 µg/m^3 of NO_2 or PM_{10}) (<18.75µg/m^3 of $PM_{2.5}$)	Negligible	Negligible	Slight Adverse
Decrease with Proposed Road Development			
Above Objective/Limit Value Without Proposed Road Development (≥40 µg/m^3 of NO_2 or PM_{10}) (≥25µg/m^3 of $PM_{2.5}$)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value Without Proposed Road Development (36-<40 µg/m^3 of NO_2 or PM_{10}) (22.5-<25µg/m^3 of $PM_{2.5}$)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value Without Proposed Road Development (30-<36 µg/m^3 of NO_2 or PM_{10}) (18.75-<22.5 µg/m^3 of $PM_{2.5}$)	Negligible	Slight Beneficial	Slight Beneficial

[3] Where the impact magnitude is imperceptible, then the impact description is negligible.

Absolute Concentration in Relation to Objective/Limit Value	Change in Concentration[3]		
	Small	**Medium**	**Large**
Well Below Objective/Limit Value Without Proposed Road Development (<30 µg/m^3 of NO_2 or PM_{10}) (<18.75µg/m^3 of $PM_{2.5}$)	Negligible	Negligible	Slight Beneficial

Table 16.6: Air Quality Impact Descriptors for Changes to Number of Days with PM_{10} Concentration Greater than 50µg/m^3 at a Receptor

Absolute Concentration in Relation to Objective/Limit Value	Changes in Concentration[4]		
	Small	**Medium**	**Large**
Increase with Proposed Road Development			
Above Objective/Limit Value with Proposed Road Development (≥35 days)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value with Proposed Road Development (32-<35 days)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value with Proposed Road Development (26-<32 days)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective/Limit Value with Proposed Road Development (<26 days)	Negligible	Negligible	Slight Adverse
Decrease with Proposed Road Development			
Above Objective/Limit Value Without Proposed Road Development (≥35 days)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value Without Proposed Road Development (32-<35 days)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value Without Proposed Road Development (26-<32 days)	Negligible	Slight Beneficial	Slight Beneficial
Well Below Objective/Limit Value Without Proposed Road Development (<26 days)	Negligible	Negligible	Slight Beneficial

The significance criteria outlined above varies slightly from that outlined in the EPA guidelines. A substantial impact is rated as a significant/profound impact from the EPA guidelines.

Due to the number of sensitive ecological sites in the vicinity of the proposed road development, a detailed assessment of the potential impacts upon sensitive ecosystems has been carried out. The significance criteria is applied to the assessment of NO_x impacts at the ecological sensitive sites as described in **Tables 16.4, 16.5** and **16.6**.

[4] Where the impact magnitude is imperceptible, then the impact description is negligible.

Construction criteria

As stated in the TII Guidance it is *"very difficult to accurately quantify dust emissions arising from construction activities". "A semi quantitative approach is recommended to determine the likelihood of a significant impact, which should be combined with an assessment of the proposed mitigation measures"*. The semi-quantitative assessment methodology outlined in **Table 16.7** is used to assess the impact of dust during the construction phase.

Table 16.7: Assessment Criteria for the Impact of Dust Emissions from Construction Activities with Standard Dust Control Measures Mitigation in Place

Source		**Potential distance for Significant Effects (Distance from Source)**		
Scale	**Description**	**Soiling**	**PM_{10}[a]**	**Vegetation Effects**
Major	Large construction sites, with high use of haul routes	100 m	25 m	25 m
Moderate	Moderate sized construction sites, with moderate use of haul routes	50 m	15 m	15 m
Minor	Minor construction sites, with limited use of haul routes	25 m	10 m	10 m

Note: [a] Significance based on the PM_{10} Limit Values specified in SI No. 180 of 2011, which allows 35 daily exceedances/year of 50 µg/m³

TII guidance states that dust emissions from construction sites can lead to elevated PM_{10} concentrations and can cause soiling of properties.

The potential impact of dust emissions during the construction phase is assessed by estimating the area over which there is a risk of significant impacts, in line with the TII guidance. The impact of construction dust on sensitive habitats is also considered, and additional mitigation measures proposed, as required. The TII Guidelines do not provide a definition of 'standard mitigation', however, the following is assumed:

- Spraying of exposed earthwork activities and site haul roads during dry weather
- Provision of wheel washes at exit points
- Control of vehicle speeds and speed restrictions. It is proposed that site traffic is restricted to 20km/hr. This will help to minimise the occurrence of dust re-suspension.
- Sweeping of hard surface roads

16.2.3 Data Sources and Consultations

The Environmental Protection Agency (EPA) is responsible for coordinating and managing air quality monitoring in accordance with relevant legislation. This includes a nationwide network of 33 monitoring stations which measures levels of air pollutants and delivers this information in real-time. This data along with on-site monitoring data is used to establish the baseline air quality in the study area.

Consultations were undertaken with stakeholders during the design development process, refer to **Chapter 1, Introduction**. Any comments that related to air quality and climate were considered during the preparation of this chapter.

16.2.4 Study area and Baseline Data Collection

The DMRB states *that only properties and designated sites within 200m of the roads affected by the project need be considered*. On this basis, properties located within 200m of the edge of the proposed road development are considered in the assessment and is the extent of the study area for the air quality and climate appraisal for this EIAR.

As described in **Section 16.2.3**, long-term baseline data provided by the EPA is used in the assessment. Since the commencement of the environmental studies for the proposed road development, the EPA has published air quality data for 2014 and 2015, this is included in the description of the receiving environment in **Section 16.3**.

16.2.5 Impact Assessment Methodology

16.2.5.1 Air Quality

Monitoring data conversion methodology

Three months of site specific air quality monitoring was carried out in the vicinity of the proposed road development. Appendix 2 of the TII *Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes, 2011* provides a methodology to calculate the annual mean from short-term monitoring. This is based on long term published monitoring data from the EPA from appropriate monitoring stations. Using this approach, predicted annual mean concentrations of PM and NO_2 were made. **Table 16.8** outlines the calculation method for estimating annual mean averages of pollutant concentrations.

Table 16.8: Formula for calculating annual average concentration from short term data

Abbreviation	Unit	Description
M	µg/m^3	Measured average from monitoring carried out (06/02/17 to 01/05/17).
A	µg/m^3	Annual average from Zone C monitoring station. As taken from EPA published data for 2014, 2015 and 2016.
P	µg/m^3	Period mean from Zone C monitoring station (06/02/17 to 01/05/17). As taken from EPA published datasets.
R		Ratio of A/P.
E	µg/m^3	Estimated annual mean (M x R).

DMRB methodology

In accordance with the TII guidelines, the DMRB Screening Method (Version 1.03c) spreadsheet is used in this assessment. This spreadsheet calculates annual average concentrations of NOx (for the assessment of nitrogen deposition), NO_2, CO, benzene, PM_{10} and $PM_{2.5}$ and was used to assess the air quality impact of the proposed road development.

The DMRB spreadsheet method computes concentrations of pollutants at a local and regional level based on factors including:

- Location and distance of sensitive receptors to proposed road development
- Annual average daily traffic (AADT) flows, refer to **Chapter 6, Traffic Assessment and Route Cross-section**
- Average speed of traffic
- Traffic composition
- Road type and length
- Background pollutant concentrations

The spreadsheet was used to assess the potential local and regional air quality impacts and potential climate impacts.

The scenarios modelled for the purpose of the air quality assessment are described below:

- The 'Do-Minimum' (DM) Scenario assumes that the proposed road development is not constructed with traffic scenarios for 2024 (Opening Year) and 2039 (Design Year)
- The 'Do-Something' (DS) Scenario assumes that the proposed road development is constructed with traffic scenarios for 2024 and 2039

The air quality assessment utilises traffic predictions for 2024 and 2039 outlined in **Chapter 6, Traffic Assessment and Route Cross-section**.

The M17/M18 Junction with the M6 is a committed development in the area. Traffic associated with this development has been included in all the scenarios.

Potential air quality impacts at all sensitive receptors are considered. Sensitive receptors are described in the TII guidelines as residential housing, schools, hospitals, places of worship, sports centres and shopping areas as well as designated ecological areas.

ADMS-Roads model

The Environmental Protection Agency (EPA) State of the Environment Report, 2016 – An Assessment states that the *failure of real-world emissions of NOx Euro 5 class vehicles to meet the standards set for them has had a disproportionate impact on ambient air (EEA, 2015). Euro 5 class vehicles showed a reduction in NO_2 emissions in laboratory tests; however, these reductions were not observed in real world driving. As a result, projections of NO_2 emission reductions did not come true and an increase in vehicle numbers actually led to increasing NO_2 levels across*

Europe. In order to fully consider the potential air quality impacts associated with actual vehicle emissions compared to laboratory tests, the ADMS-Roads version 4 atmospheric dispersion model has been used.

The assessment follows the methodology set out in Defra's Local Air Quality Management Technical Guidance (LAQM.TG16) for aspects not covered by the TII Guidelines. The Defra guidance also states that exceedances of the NO_2 1-hour mean is unlikely to occur where the annual mean is below 60µg/m^3. Both the DMRB and ADMS-Roads models only predict annual means for NO_2.

The assessment scenarios are as prepared for the DMRB screening model.

ADMS-Roads has been used to predict NO_x, PM_{10} and $PM_{2.5}$ concentrations. Predicted NO_x concentrations have been processed to determine annual mean NO_2 concentrations for comparison with the annual mean NO_2 objectives.

Vehicle emissions and background air quality are predicted to improve over time due to the introduction of cleaner vehicles into the vehicle fleet. However, there is uncertainty as to how successful the implementation of stricter controls of vehicle emissions will be. To account for this uncertainty modelling has been carried out assuming no improvement in vehicle emissions nor background concentrations for the future scenarios. This represents a worst case scenario, as some improvements are likely during this period.

The traffic data used for this assessment consisted of 24-hour AADT flows, the percentage of heavy goods vehicles (HGVs) and free flow speeds, refer to **Chapter 6, Traffic Assessment and Route Cross-section** for traffic data. The speeds provided were based on the free flow speeds for each road link. As recommended in TII Guidelines, traffic speeds were slowed at junctions to 20kph, for a distance of 50m from the yield/stop line.

In accordance with TII guidelines, emission rates have been calculated using the Defra Emissions Factor Toolkit (EFT) v7[5]. Emission factors from 2015 have been used in all modelled scenarios as a worst-case.

Details of the locations and heights of the proposed noise barriers were also considered in this assessment. Noise barriers located close to the modelled sensitive air receptors have been included in the air modelling. Modelling has been carried out with and without the noise barriers, to determine their potential to change air quality at the receptor. Refer to **Chapter 17, Noise and Vibration** and **Figures 17.1.101** to **17.1.114** for details on these noise barriers.

Receptor Locations

Worst-case receptors, such as close to junctions and those close to the kerbside, were selected as part of the DMRB and ADMS assessments. Their locations are shown in **Figures 16.1.1** to **16.1.14**, except where the receptors are located away from the proposed road development. The location and height of the receptors are

[5] Defra Emission Factor Toolkit v7 (http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html) accessed September 2016

given in **Table 16.9**. A height of 1.5m corresponds to typical inhalation height at a ground floor property.

Table 16.9: Modelled Receptors

Receptor ID	Receptor type	OS Grid Ref.		Receptor height (m)
		X m	Y m	
R01	Existing residential	536,615	727,586	1.5
R02	Existing residential	535,241	725,853	1.5
R03	Existing residential	534,969	726,070	1.5
R04	Existing residential	521,445	722,560	1.5
R05	Existing residential	522,744	724,933	1.5
R06	Existing residential	531,123	728,633	1.5
R07	Existing residential	531,798	729,727	1.5
R08	Existing residential	534,233	729,639	1.5
R09	Existing residential	520,933	722,606	1.5
R10	Existing residential	524,663	724,483	1.5
R11	Existing residential	525,399	725,642	1.5
R12	Existing residential	525,456	725,772	1.5
R13	Existing residential	527,200	727,837	1.5
R14	Existing residential	534,360	727,286	1.5
R15	Existing residential	534,058	727,892	1.5
R16	Existing residential	531,883	728,299	1.5
R17	Existing residential	527,677	727,212	1.5
R18	Existing residential	527,140	727,585	1.5
R19	Existing residential	527,119	726,074	1.5
R20	Existing residential	527,179	726,411	1.5

Receptor ID	Receptor type	OS Grid Ref.		Receptor height (m)
		X m	Y m	
R21	Existing residential	526,125	726,154	1.5
R22	Existing residential	525,409	725,641	1.5
R23	Existing residential	524,461	725,030	1.5
R24	Existing residential	522,053	723,855	1.5
R25	Existing residential	521,600	723,561	1.5
R26	Existing residential	546,359	726,194	1.5
R27	Existing residential	549,739	726,283	1.5
R28	Existing residential	545,146	727,935	1.5

An air quality modelling assessment was undertaken using ADMS to consider potential additional impacts at the locations of the proposed tunnel portals. Details of the tunnels as modelled are given in **Table 16.10**.

Table 16.10: Tunnel locations

Tunnel		OS Grid Ref	Bore depth (m)	Outflow link	Outflow width (m)
Galway Racecourse eastbound	Entrance portal	533809, 728070	6	51_T_EB_W	13.45
	Exit portal	533973, 727894	6	51_T_EB_E	11.95
Galway Racecourse westbound	Entrance portal	533962, 727885	6	51_T_WB_E	13.0
	Exit portal	533799, 728059	6	51_T_WB_W	13.0
Lackagh eastbound	Entrance portal	530107, 728408	8.1	53_T_EB_W	10.9
	Exit portal	530372, 728444	6	53_T_EB_E	10.9
Lackagh westbound	Entrance portal	530357, 728420	6	53_T_WB_E	10.9
	Exit portal	530108, 728387	8.1	53_T_WB_W	10.9

The proposed road development crosses the Lough Corrib cSAC. Concentrations of NO_x along four 200m transects from where the proposed road development crosses the Lough Corrib cSAC have been modelled. Transects 1 to 3 were selected due to their proximity to the Lackagh Tunnel portals. Transect 4 was selected as the location where the Lough Corrib cSAC is closest to the proposed road development. The ecological transects and their location in relation to the proposed road development, Lackagh Tunnel portals and Lough Corrib cSAC are shown in **Plate 16.1** and **16.2**.

Plate 16.1: Lough Corrib cSAC, Lackagh Tunnel portals and ecological transects 1 to 3

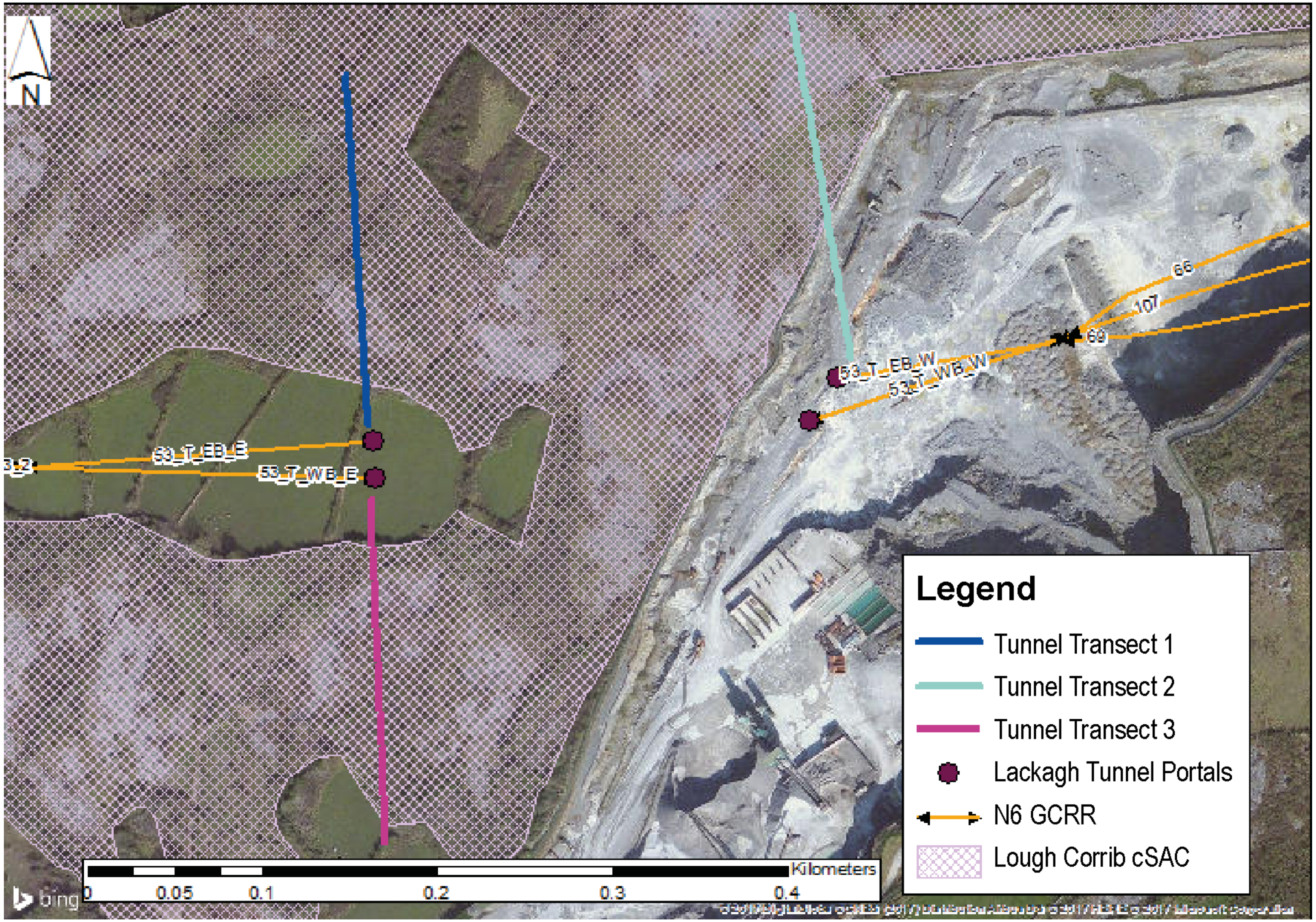
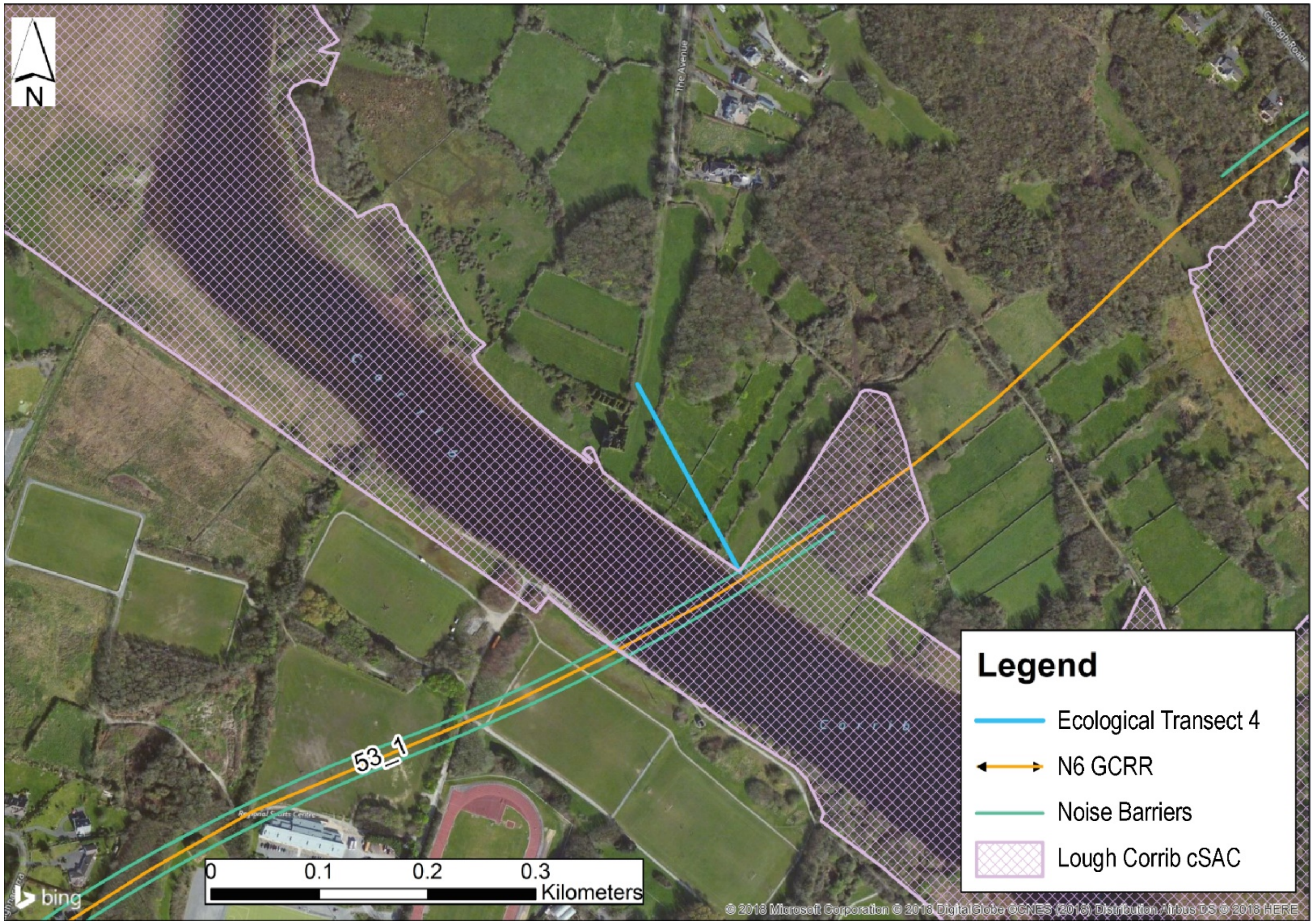


Plate 16.2: Lough Corrib cSAC and ecological transect 4



Ecological impact assessment

The UK DMRB states that some air pollutants can have an effect on vegetation. Concentrations of pollutants in air and deposition of particles can damage vegetation directly or affect plant health and productivity. It states that the pollutants of most concern for sensitive vegetation near roads, and perhaps the best understood, is NO_x. It refers to the EU limit set for NO_x for the protection of vegetation. This value was based on the work of UNECE and WHO and has been implemented into the Irish air quality standards. The report states that *'critical loads for the deposition of nitrogen represents the exposure below which there should be no significant harmful effects on sensitive elements of the ecosystem (according to current knowledge)'*. In relation to heavy metals, the manual states that *small quantities of heavy metals released during combustion and from vehicle wear and tear may accumulate in soils near the road. However, such emissions cannot be reliably quantified or the negative ecological effects determined*.

The manual describes the assessment procedure to be used to assess the impact of air pollution on ecologically sensitive sites. The procedure was developed in collaboration with the Joint Nature Conservation committee and Natural England and adopted by the TII in its guidelines.

The Natural England report 'the Ecological Effects of Air Pollution from Road Transport' published in 2004 and the 2016 update were reviewed in the context of this assessment. These reports were commissioned to assess the potential risk to biodiversity due to air pollution from roads.

The reports summarise studies carried out to determine the effect of traffic emissions on NOx and nitrogen deposition on various species. In general, the study concludes that a review of relevant studies *provides further evidence of the impacts on individual species from exposure to NO_x and NO_2 associated with vehicle emissions and that these are greatest within the first 50-100m from the roads but may be discernible at greater distances.*

In relation to Volatile Organic Compounds (VOCs), the report states that most studies testing the responses of plants exposure to VOCs have used high concentrations over short exposure periods (hours or days). Therefore, the effects of exposure to low concentrations of VOC is difficult to determine. Also, few of the studies tested the responses of vegetation to the species of VOCs emitted by vehicles. Studies have generally concentrated on the effects of ethylene which is emitted by motor vehicles and naturally occurring in plants. The report also states that *levels of ethylene likely to be found in the vicinity of roads may be high enough to adversely affect sensitive species*. Sensitive species include flowers, fruit, seed production and morphology. *The report concludes that the response of vegetation to other VOCs emitted by motor vehicles is unclear; although possible effects are degradation of leaf surface waxes, pigment bleaching and ultra-structural changes.*

In relation to metals, the report states:

The studies also evidence that traffic emissions are a significant source of metal contamination for vegetation close to roads, although the leaf concentrations recorded are unlikely to present a significant immediate toxic risk to plants.

Metals are likely to persist in soils and levels may therefore build up over time in the vicinity of roads. A number of laboratory studies have cultured a variety of plant species in soil containing elevated concentrations of heavy metals and have found a range of tolerances depending on the species tested.

There is the potential for elevated concentrations of metals in soils close to roads. However, the report also states that soil metal content is generally only substantially elevated within 20-30m from even the busiest of roads.

In relation to ammonia, the report states:

Ammonia is emitted in small amounts by vehicles with catalytic converters and roadside atmospheric concentrations are well below critical levels for this pollutant (UK Critical Levels Advisory Group, 1996). Gaseous ammonia is thus unlikely to be a key issue, and effects on vegetation are more likely to arise from enhanced deposition of nitrogen to the soil environment. This elevation in soil nitrogen will be limited to areas within tens of metres of roads due to the high rates of deposition of this gas.

In relation to particulates/dust, the following is stated:

Few attempts have been made to assess the impacts of particulates and dust from motor vehicles on vegetation under controlled conditions… The authors conclude that it is difficult to assess the significance of these results for roadside plants under realistic conditions.

16.2.5.2 Climate

The Construction Carbon Calculator was published by the UK Environment Agency in July 2012. The carbon calculator measures the greenhouse gas impacts of construction activities in terms of carbon dioxide equivalency (CO_2e). It does this by calculating the embodied CO_2e of materials plus the CO_2e associated with their transportation. It also considers personnel travel, site energy use and waste management.

The potential impact of the proposed road development on carbon emissions was assessed using the DMRB spreadsheet as described in **Section 16.2.8.1**.

The potential micro-climatic impacts of the proposed road development were assessed in relation to existing micro-climatic conditions, the size of the proposed road development and the nature of use of the surrounding environment.

16.3 Receiving Environment

16.3.1 Introduction

The receiving environment for this appraisal comprises of local air quality, national air quality and climate.

Road traffic on the national routes (including the existing N6, N83[6], N67, N59 and N84) and on the local road network is currently generating levels of pollution. Emissions are higher under congested traffic conditions, such as those experienced in certain areas of Galway City, particularly during peak times. The EPA carries out air quality monitoring at Bodkin Junction in Galway. PM_{10} and heavy metals levels are shown to comply with air quality standards in 2017 (www.epa.ie).

Heating for residential and commercial premises currently generates levels of pollution, particularly in the areas of higher density population in Galway City and suburbs. Agricultural activities also generate pollution due to farming plant and dust generating activities.

There are operational quarries located in proximity to the proposed road development. There is the potential for windblown dust to be generated from open faces and stockpiles.

Table 16.11 presents a list of industrial facilities licenced by the EPA within the study area, under Industrial Emissions (IE) or Integrated Pollution Licence (IPC).

Table 16.11: EPA IE/IPC Licence holders within the vicinity of the proposed road development

Licence No	Company	Address	IPC/IED
P0264-02	Medtronic Vascular Galway	Parkmore Industrial Estate, Galway	IPC
P0725-01	Boston Scientific Ireland Limited	Ballybrit Upper Industrial Estate, Galway	IPC
P0994-01	Ingersoll Rand Limited	Monivea Road, Mervue, Galway	IE
P0339-01	F & T Buckley Limited	Wellpark, Galway, Co Galway	IPC
P0324-01	Hygeia Chemicals Limited	Carrowmoneash, Oranmore, Co Galway	IPC
P0056-01	Cold Chon (Galway) Limited	Oranmore, Co Galway	IE
P0133-02	APW Galway Limited	Deerpark Industrial Estate, Oranmore, Co Galway	IPC
P1006-02	Galway Metal Company Limited	Carrowmoneash, Oranmore, Co Galway	IE

[6] Formally known as the N17 Tuam Road

Licence No	Company	Address	IPC/IED
P0264-02	Medtronic Vascular Galway	Parkmore Industrial Estate, Galway	IPC

In addition to the air emission sources outlined above, the effect of the emission sources presented in the above table are likely to be reflected in the baseline air monitoring data presented in **Table 16.12**.

Sensitive receptor locations within the scheme study area are defined in the guidelines as residential housing, schools, hospitals, places of worship, sports centres and shopping areas, i.e. locations where members of the public are likely to be regularly present. In addition, sensitive ecological sites are considered in the assessment.

16.3.2 Local Air Quality data from EPA long-term monitoring

The TII Guidelines advise that if sufficient data is available and pollutant concentrations are well below air quality standards then existing published data can be used as a baseline.

The Air Quality Standards (AQS) Regulations describe the air quality zoning adopted in Ireland as follows:

- Zone A (Dublin Conurbation)
- Zone B (Cork Conurbation)
- Zone C (16 Cities and Towns with population greater than 15,000, including Naas)
- Zone D (Rural Ireland: areas not in Zones A, B and C)

The proposed road development falls within the vicinity of Galway City and is therefore considered in Zone C.

Background levels from 2016, 2015 and 2014 air quality monitoring of NO_x, NO_2, CO, benzene, $PM_{2.5}$ and PM_{10} in Zone C provided by the EPA are presented in **Table 16.12**.

Concentrations of each pollutant recorded in Zone C are averaged to represent typical background levels. Average concentrations were obtained from all Zone C stations where 90% data capture was achieved. This is in accordance with the air quality standards which specifies that any site used for assessment purposes must comply with 90% data capture. For pollutants where the 90% capture rule was not achieved at any Zone C sites, the average of other sites was taken instead. Where no validated data exists for Zone C, Zone B data was used as it is expected to be similar or higher than Zone C data, resulting in a worst-case.

Table 16.12: Annual Mean Background Pollutant Concentrations for Zone C

Year	Pollutants	Time Period	Location	Measured concentrations µg/m³	Air Quality Standard µg/m³	% of Air Quality Standard
2016	NO_2	Annual average	Zone C	8.8	40	22
	NO_x	Annual average	Zone C	14.3	30	47.6
	CO	8-hour annual average	Zone C	400	10,000	4
	$PM_{2.5}$	Annual average	Zone B	7	25	28
	PM_{10}	Annual average	Zone C	15.3	40	38.2
	Benzene	Annual average	Zone A	1.01	5	20.2
2015	NO_2	Annual average	Zone C	7.5	40	18.8
	NO_x	Annual average	Zone C	11.5	30	38.3
	CO	8-hour annual average	Zone C	400	10,000	4
	$PM_{2.5}$	Annual Average	Zone C	9.5	25	38
	PM_{10}	Annual Average	Zone C	15	40	37.5
	Benzene	Annual Average	Zone C	0.1	5	2.6
2014	NO_2	Annual average	Zone C	5	40	12.5
	NO_x	Annual average	Zone C	8	30	26.7
	CO	8-hour annual average	Zone C	200	10,000	3
	$PM_{2.5}$	Annual average	Zone B	12	25	48
	PM_{10}	Annual average	Zone C	21	40	52.5
	Benzene	Annual average	Zone B	0.1	5	2.6

All current baseline concentrations are in compliance with AQS. Note that concentrations of PM_{10} slightly exceed the WHO guideline of 20µg/m³ in 2014. Concentrations of $PM_{2.5}$ slightly exceed the WHO guideline of 10µg/m³ in 2014.

The EPA State of the Environment Report, 2016 – An Assessment states that in recent years while *exhaust emission limits become stricter, this is offset by increases in the numbers of cars. New EU emissions standards for vehicles, cleaner technology, and a reduction in the number of vehicles using the roads as a result of the economic downturn led to a decrease in NO_2 in our urban centres. However, this is unlikely to continue into the future. Economic recovery will most likely lead to an increase in NO_2 levels. The failure of real-world emissions of NOx Euro 5 class vehicles to meet the standards set for them has had a disproportionate impact on ambient air (EEA, 2015). Euro 5 class vehicles showed a reduction in NO_2 emissions in laboratory tests; however, these reductions were not observed in real world driving. As a result, projections of NO_2 emission reductions did not come true and an increase in vehicle numbers actually led to increasing NO_2 levels across Europe.*

Average background concentrations are provided in **Table 16.13**. The TII Guidance provides correction factors to predict background levels for future assessment years to take into account concentration decreases in future years due to improved vehicle technology etc. However, in order to consider a worst-case scenario, no improvement is assumed and current values are used for future years. Although uncertainty regarding future year emission factors relates primarily to NO_x emissions, it should be noted that the same approach of holding vehicle emission factors and background pollutant concentrations has been taken for PM_{10} and $PM_{2.5}$ concentrations.

Table 16.13: Average background concentrations

Pollutant	Average concentration μg/m^3 (2014 to 2016)	Air Quality Standard μg/m^3
NO_2	7.1	40
NO_x	11.2	30
CO	333	10,000
$PM_{2.5}$	9.5	20
PM_{10}	17.1	40
Benzene	0.4	5

Average background concentrations are in compliance with Air Quality Standards.

Modelled background concentrations for 1990, 2000 and 2020 nitrogen deposition are provided in the EPA research document *'Development of Critical Loads for Ireland: Simulating Impacts on Systems (SIOS)*, Aherne, Henry and Wolniewicz. In the area of the proposed road development, background levels are in the range of 1 to 2.5kg(N)/ha/yr.

16.3.3 Site specific air quality monitoring

16.3.3.1 Monitoring results

Site specific monitoring of PM and NO_2 was carried out over a period of three months, refer to **Appendix 16.1** for full monitoring report. As outlined in **Section 16.2.5.1**, concentrations can be adjusted using TII methodology for comparison with annual mean limits outlined in the air quality standards.

This approach utilises data from each of the monitoring stations contained within the appropriate zone, in this case Zone C. Individual annual average concentrations for PM and NO_2 have been calculated using three years of monitoring data (2014-2016) from all Zone C stations where 90% data capture was achieved. This is in accordance with the air quality standards which specifies that any site used for assessment purposes must comply with 90% data capture. Where the 90% capture rule was not achieved at any Zone C sites, Zone B data was used as it is expected to be similar or higher than Zone C data, resulting in a worst-case.

It should be noted that only datasets with sufficient coverage over the three month period from 6 February to 2 May for each assessment year have been used, in accordance with air quality standards.

PM_{10} and $PM_{2.5}$

Schedule 11 of the Air Quality Standards Regulations states that PM_{10} concentrations should not exceed 50μg/m^3 more than 35 times in a calendar year over one day periods (24-hours) or exceed 40μg/m^3 over an annual period. For $PM_{2.5}$, concentrations should not exceed 25μg/m^3 over an annual period. There were no such exceedances during the monitoring period.

Table 16.14 outlines the monitoring data for PM_{10} and $PM_{2.5}$ from 6 February to 2 May 2017.

Table 16.14: Average PM_{10} and $PM_{2.5}$ concentration (μg/m^3) for 24-hour period from 6 February - 2 May 2017

Monitoring Period	Daily average (μg/m^3)	
	PM_{10}	$PM_{2.5}$
6 February to 2 May 2017	9.72	5.36

Table 16.15 outlines the calculated average concentrations of PM_{10} based on the method outlined in **Table 16.8**.

Table 16.15: Predicted annual average PM_{10} concentration (μg/m^3)

Zone C Monitoring station	Galway	Portlaoise	Ennis	Ennis
Year	**2016**	**2015**	**2015**	**2014**
Measured 3-month average (μg/m^3) - M	9.72			
Annual average (μg/m3) –A	15.3	12	18	21
Period average (3-month average) (μg/m^3) – P	16	15.9	22.4	21.3
Ratio of A/P - R	0.95	0.75	0.8	0.98
Estimated annual average (μg/m^3) - E	8.83	7.29	7.77	9.52
Average of estimated annual averages (μg/m^3)	8.35			

The predicted annual average PM_{10} concentration is in compliance with the annual air quality standard of 40μg/m^3 and the WHO guideline of 20μg/m^3.

Table 16.16 outlines the calculated average concentrations of $PM_{2.5}$ based on the method outlined in **Table 16.8**.

Table 16.16: Predicted annual average PM2.5 concentration (µg/m^3)

Zone C Monitoring station	Heatherton Park*	Bray	Ennis	Coleraine St**	Rathmines**	Finglas**	Marino**
Year	**2016**	**2015**	**2015**	**2014**	**2014**	**2014**	**2014**
Measured 3-month average (µg/m^3) - M	5.36						
Annual average (µg/m^3) –A	7	7	12	9	9	7	8
Period average (3-month average) (µg/m^3) – P	8.1	8	13	10.1	9.7	9.5	8.6
Ratio of A/P - R	0.86	0.87	0.92	0.89	0.92	0.73	0.93
Estimated annual average (µg/m^3) - E	4.6	4.6	4.93	4.77	4.93	3.91	4.98
Average of estimated annual averages (µg/m^3)	4.67						

* Data obtained from Zone B Monitoring Station as no data available from Zone C Stations where 90% data capture was achieved
** Data obtained from Zone A Monitoring Stations as no data available from Zone C or Zone B Stations where 90% data capture was achieved

The predicted annual average $PM_{2.5}$ concentration is in compliance with the annual air quality standard of 20µg/m^3 and the WHO guideline of 10µg/m^3.

NO_2

Table 16.17 outlines the monitoring data for NO_2 from the 6 February to 2 May 2017.

Table 16.17: Average NO_2 concentration (µg/m^3) for monthly period from 6 February - 2 May 2017

Time Period	Location 1 (µg/m^3)	Location 2 (µg/m^3)	Location 3 (µg/m^3)	Location 4 (µg/m^3)
6 February to 6 March 2017	8.2	9.09	11.06	20.45
6 March to 6 April 2017	5.58	6.29	9.29	8.66
3 April to 2 May 2017	8.75	4.22	7.02	10.82
Average (µg/m^3)	7.51	6.53	9.12	13.31
Average for all four locations (µg/m^3)	9.12			

Table 16.18 outlines the calculated average concentrations of NO_2 based on the method outlined in **Table 16.8**.

Table 16.18: Predicted annual average NO_2 concentration (µg/m^3)

Zone C Monitoring station	Kilkenny Seville Lodge	Portlaoise	Kilkenny Seville Lodge	Kilkenny Seville Lodge
Year	**2016**	**2016**	**2015**	**2014**
Measured 3-month average (µg/m^3) - M	9.12			
Annual average (µg/m^3) –A	6.6	11.1	5	5
Period average (3-month average) (µg/m^3) – P	6.9	10.1	5.03	4.7
Ratio of A/P - R	0.95	1.09	0.99	1.06
Estimated annual average (µg/m^3) - E	8.66	9.94	9.02	9.66
Average of estimated annual averages (µg/m^3)	9.32			

The predicted annual average NO_2 concentration is in compliance with the annual air quality standard of 40µg/m^3 and the WHO guideline of 40µg/m^3.

16.3.3.2 Selection of background data for modelling assessments

Table 16.19 presents background data from EPA published data and from the assessment presented in **Section 16.3.3.1**.

Table 16.19: Background pollutant concentrations

Pollutant	Average concentration 2014 to 2016 (μg/m^3)	Predicted average concentration from monitoring data (μg/m^3)	Background value selected for assessments (μg/m^3)	Air Quality Standard (μg/m^3)
NO_2	7.1	9.3	9.3	40
PM_{10}	17.1	8.4	17.1	40
$PM_{2.5}$	9.5	4.7	9.5	20
Benzene	0.4	n/a	0.4	5
NO_x	11.2	n/a	11.2	30
CO	333	n/a	333	10,000

As a worst case, the highest level background data has been selected for use in the modelling assessments.

16.3.4 National Air Quality

In 2015, the EPA in a press release reported that emissions of nitrogen oxides (NO_x) decreased by 45% between 1990 and 2013. Between 2010 and 2011 there was a 10% reduction, caused by reductions across all sectors and in particular power generation. Despite this reduction, Ireland is currently exceeding its 2010 NO_x ceiling of 65 kilotonnes by 11 kilotonnes in 2013.

The road transport sector represents the largest source of NO_x emissions, accounting for 53% of total NO_x emissions in 2013.

The national total emissions of VOC were 90 kilotonnes in 2013 which exceeds the ceiling of 55 kilotonnes. Transport emissions comprise approximately 8% of total VOC emissions. However, technological controls for VOCs in motor vehicles have led to a significant reduction in emissions from road transport in recent years.

16.3.5 Macro climate

In April 2017, the EPA produced the report 'Ireland's final greenhouse gas emissions in 2015'. This concluded that there was an increase of 4.2% or 0.48Mtonnes of CO_{2eq} from the transport sector in 2015. This is the third year of increases in transport emissions following five consecutive years of decreases since 2007. The increase primarily reflects higher usage of diesel with gasoline usage decreasing. It is noted that biofuels use increased in 2015 by 10.3%.

In March 2016, the EPA reported that Ireland is unlikely to meet 2020 EU greenhouse gas targets for all sectors including transport. Current projections indicate that Ireland will be 6-11% below 2005 levels by 2020. This falls well short of the target of 20% below 2005 levels by 2020. Transport is predicted to constitute 29% of Ireland's non-Emissions Trading Scheme (ETS) emissions in 2020.

16.3.6 Micro-climate

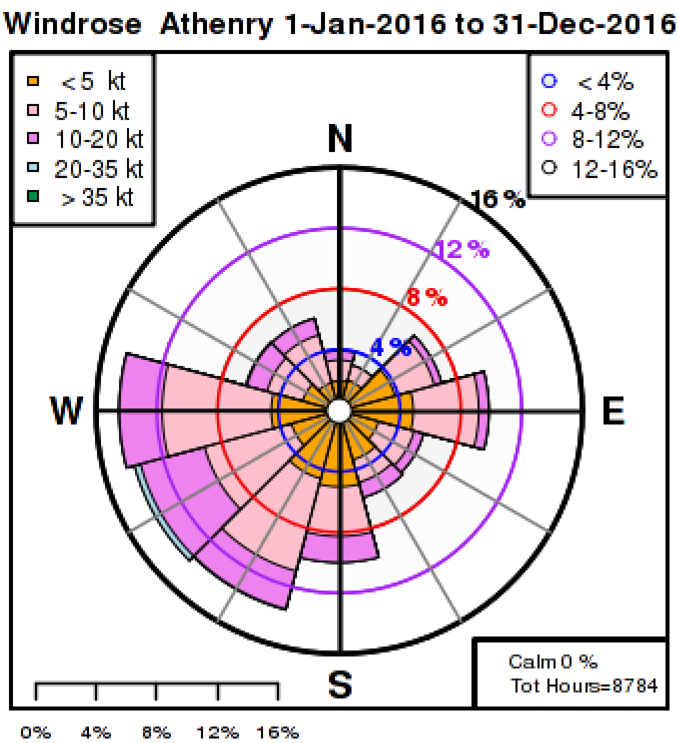
The nearest representative Met Éireann synoptic meteorological station is at Athenry which is located approximately 20km east of the proposed road development at 47m above mean sea level. Meteorological data is only available at this station from July 2011. All climate data cited below is taken from the 6 year averages reported for Athenry meteorological station (www.met.ie).

The annual mean temperature is 9.8ºC. The annual mean of daily maxima is 13.6ºC and of daily minima is 6ºC.

The mean annual rainfall is 1,004mm.

The annual mean wind speed is 3.9m/s (7.5 knots). A windrose for Athenry meteorological station is provided in **Plate 16.3** (www.met.ie).

Plate 16.3: Windrose for Athenry 2016



16.4 Characteristics of the Proposed Development

16.4.1 Construction Phase

The construction of the proposed road development will require earthworks, particularly during site clearance and excavation, refer to **Chapter 7, Construction Activities** for further details. Dust emissions are likely to arise from the following activities:

- Site earthworks
- Windblow from temporary stockpiles
- Handling of construction materials
- Landscaping
- Construction traffic movements
- Demolitions
- Concrete batching and crushing

In general, any additional airborne concentrations of particulate matter arising from construction would be small and very local to the construction activity (minimising human exposure). Particles generated by most construction activities tend to be larger than 10µm in diameter which are too large to enter the human lung.

Based on the assessment criteria outlined in **Table 16.7**, the potential dust impacts at locations where the main construction works will occur are assessed in **Section 16.5**.

A number of construction compounds are proposed, refer to **Figures 7.101** to 7.**123** for the locations of these compounds. The main construction compound will be located at Lackagh Quarry. It is assumed that concrete batching and rock crushing plant will be utilised at each compound.

It is also expected that a mobile crushing plant will be used in areas where extensive cut is required.

16.4.2 Operational Phase

The proposed road development comprises the construction of a single carriageway from the western side of Bearna as far as the Ballymoneen Road and a dual carriage from here to the eastern tie in with the existing N6 at Coolagh with associated link roads.

Predicted traffic volumes are outlined in **Chapter 6, Traffic Assessment and Route Cross-section**.

16.5 Evaluation of Impacts

16.5.1 Introduction

The following sections consider the potential impact of the proposed road development on air quality and climate during the construction and operational phases. The construction assessment considers potential impacts due to construction activities and traffic. The operational phase assesses the potential impact locally and regionally due to traffic emissions.

16.5.2 Do-Nothing Impact

The Do-nothing impact is considered and compared to the Do-Something scenarios in **Section 16.5.4**.

16.5.3 Potential Construction Impacts

16.5.3.1 Construction Activities

As outlined in **Section 16.4**, the construction of the proposed road development will require earthworks, particularly during site clearance and excavation.

Based on the assessment criteria outlined in **Table 16.7**, the potential dust impacts at locations where the main construction works will occur are assessed. The proposed road development has been split into six sections for the purpose of this assessment as outlined below. The sensitive receptors are shown on **Figures 16.01** to **16.14**.

Section 1: Ch. 0+000 to 5+600 (R336 to Ballymoneen Road Junction)

A single carriageway is proposed from Ch. 0+000 to Ch. 5+600 totalling 5.6km in length. This section of the proposed road development includes one new roundabout with a number of side road realignments, refer to **Table 5.2** of **Chapter 5, Description of proposed road development**. Works associated with Section 1 are considered to be of a major scale (refer to **Table 16.7**). There is potential for soiling effects at receptors located within 100m of the site works and PM_{10} and vegetation effects at receptors located less than 25m from the site works with standard dust control mitigation measures in place.

There are approximately 42 sensitive receptors located within 100m at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately seven receptors are located less than 25m from the proposed site works at which there is the potential for significant PM_{10} and vegetation effects with standard dust control mitigation measures in place.

Section 2: Ch. 5+600 to 9+250 (Ballymoneen Road Junction to River Corrib Bridge)

A dual carriageway is proposed from Ch. 5+600 to Ch. 9+300 totalling 3.7km in length. This section of the proposed road development includes the N59 Letteragh Junction and approximately 2.2km of single carriageway for the N59 Link Road

North and South at Ch. 7+550. The scale of these works is considered to be of a major scale (refer to **Table 16.7**). There is potential for soiling effects at receptors located within 100 m of the site works and PM_{10} and vegetation effects at receptors located less than 25 m from the site works with standard mitigation in place.

There are approximately 39 sensitive receptors located within 100m of the works at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately six receptors are located less than 25m from construction works at which there is the potential for PM_{10} and vegetation effects with standard dust control mitigation measures in place.

Section 3: Ch. 9+250 to 12+150 (River Corrib Bridge to N84 Headford Road Junction)

Section 3 of the proposed road development is also a dual carriageway and includes the construction of the River Corrib Bridge, 650m in length at Ch. 8+840, Menlough Viaduct, 30m in length at Ch. 10+090, Lackagh Tunnel, 270m in length at Ch. 11+140 and the N84 Headford Road Junction at Ch. 12+150. The scale of these works is considered to be of a major scale (refer to **Table 16.7**). There is potential for soiling effects at receptors located within 100m of the site works and PM_{10} and vegetation effects at receptors located less than 25m from the site works with standard mitigation in place.

There are approximately 13 sensitive receptors located within 100m at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately three receptors are located less than 25m from construction works at which there is the potential for significant PM_{10} and vegetation effects with standard dust control mitigation measures in place.

Construction works will also take place in or adjacent to the Lough Corrib cSAC in Section 3. There is the potential for significant PM_{10}, soiling and vegetation effects at these locations with standard dust control mitigation measures in place.

Section 4: Ch. 12+150 to 14+300 (N84 Headford Road Junction to N83 Tuam Road Junction)

Section 4 of the proposed road development is also a dual carriageway and includes the N83 Tuam Road Junction. The construction works are considered to be of a major scale (refer to **Table 16.7**), including the construction of the N83 Tuam Road Junction.

The remainder of the works in Section 4 are considered to be of a major scale with the potential to result in soiling effects within 100m, PM_{10} and vegetation effects within 25m with standard mitigation in place.

There are approximately 29 sensitive receptors located within 100m of the works at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately five receptors less than 25m from construction works at which there is the potential for significant PM_{10} and vegetation effects within 25m of the works and the potential for significant soiling effects within 100m of the works with standard dust control mitigation measures in place.

Section 5: Ch. 14+300 to 15+900 (N83 Tuam Road Junction to R339 Monivea Road) including Parkmore

Section 5 of the proposed road development is also a dual carriageway and includes the Galway Racecourse Tunnel at Ch. 14+950 to Ch. 15+200. This is considered to be of a major scale (refer to **Table 16.7**). There is potential for soiling effects at receptors located within 100m of the site works and PM_{10} and vegetation effects at receptors located less than 25m from the site works with standard mitigation in place.

There are approximately 14 sensitive receptors located within 100m at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately two receptors are located less than 25 m from construction works at which there is the potential for significant PM_{10} and vegetation effects with standard dust control mitigation measures in place.

Section 6: Ch. 15+900 to 17+450 (R339 Monivea Road to Coolagh Junction)

Section 6 of the proposed road development is also a dual carriageway and includes the Coolagh Junction. This section is considered to be of a major scale (refer to **Table 16.7**). There is potential for soiling effects at receptors located within 100m of the site works and PM_{10} and vegetation effects at receptors located less than 25m from the site works with standard mitigation in place.

There are a number sensitive receptors located within 100m of the works at which there is the potential for significant soiling effects with standard dust control mitigation measures in place.

16.5.3.2 Construction Compounds

There are twelve sites identified as potential site compounds across the proposed road development. They have been identified at strategic locations across the proposed road development to minimise the distance for site construction traffic and personnel to travel. Sites identified have been chosen taking cognisance of proximity to major structures, excavations and embankments, proximity to residential properties, environmental constraints and current land use and ownership. Larger area compounds have the potential for material stockpiling, crushing, regrading and delivery in tandem with site offices. Refer to **Table 7.9** in **Chapter 7, Construction Activities** and **Figures 7.1.101** to **7.1.123**, for potential site compound locations.

One of the construction compounds (SC08/01) will be for the storage of materials only and therefore its impact on dust emissions has been categorised as minor scale. All other construction compounds have been categorised as moderate scale, see **Table 16.7**.

In total, approximately 16 sensitive receptors are located with 50m of the potential construction compounds at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately, two receptors are located less than 15m of the construction compounds at which there is the potential for significant PM_{10} and vegetation effects with standard dust control mitigation measures in place.

16.5.3.3 Construction traffic

As stated in **Section 16.2.5**, construction traffic impacts are assessed when traffic generated (AADT) of greater than 10% are predicted to occur due to the proposed road development. Only three links are predicted to generate traffic volumes greater than 10% during the construction phase, i.e. R336 Bearna Moycullen Road, Cappagh Road and Menlough Road. **Table 16.20** provides the predicted concentrations at the worst-case receptor (5m from the centre of the road) for each road link. All predicted concentrations are in compliance with AQS.

Table 16:20: Predicted Pollutant Concentrations Including Background Concentrations – Construction Phase

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
R336 Bearna Moycullen Road	DN	9.82	17.24	9.57	<1	343	0.5
	DS	9.92	17.26	9.58	<1	343	0.5
	DS – DN	0.1	0.02	0.01	0	0	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	Negligible	Negligible
Cappagh Road	DN	9.49	20.59	9.5	<1	334.8	0.5
	DS	9.6	20.6	9.51	<1	336.4	0.5
	DS – DN	0.11	0.01	0.01	0	1.6	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	Negligible	Negligible
Menlough Road	DN	10.22	17.34	9.66	<1	345	0.5
	DS	10.3	17.36	9.67	<1	347	0.5
	DS – DN	0.08	0.02	0.01	0	2	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	Negligible	Negligible

The impact ratings for NO_2, PM_{10} and $PM_{2.5}$ are negligible. No impact rating is provided for benzene or CO in the TII Guidance. However, due to the small changes in concentrations and the easy compliance with limit values, a rating of negligible would be expected for all pollutants.

16.5.4 Potential Operational Impacts

16.5.4.1 Local air quality impacts based on DMRB screening model

The potential impact on air quality is assessed for the Opening Year (2024) and Design Year (2039) under the 'Do-Minimum' (DM) and 'Do-Something' (DS) scenarios respectively. Pollutant concentrations are provided at the worst-case receptors, i.e. those properties that are closest to the affected links.

The results provided are based on the use of the DMRB model (refer to **Section 16.2.5.1** for methodology).

Opening Year (2024)

Predicted concentrations (including background concentrations) for the DM, and DS scenarios for the Opening Year 2024 are presented in **Table 16.21**.

The receptor where the highest concentration of pollutants are predicted (including the background concentrations) as a result of the DS scenario is Receptor 17 for NO_2, PM_{10}, $PM_{2.5}$, CO and Benzene (refer to **Figure 16.1.06**).

At this receptor, annual average concentrations of NO_2 are predicted to be 14.42µg/m³, which complies with the AQS of 40µg/m³; annual average concentrations of $PM_{2.5}$ are predicted to be 11.3µg/m³, which complies with the proposed limit value of 20µg/m³ and the annual average concentrations of PM_{10} are predicted to be 19.2µg/m³ which complies with the limit value of 40µg/m³. The number of annual days which PM_{10} levels is predicted to exceed the limit of 50µg/m³ is <3 days. This complies with the limit of 35 days. Annual average concentrations of benzene are predicted to be 0.48µg/m³, which complies with the AQS of 5µg/m³ and 8 hour concentrations of CO are predicted to be 387.2µg/m³, which complies with the AQS of 10,000µg/m³.

From **Tables 16.4**, **16.5** and **16.6**, the predicted changes in concentration of all pollutants are rated as negligible or imperceptible impacts at all receptors except at receptors, R16 and R17 where an impact of slight adverse is predicted for NO_2. No impact rating is provided for benzene or CO in the TII Guidance. However, due to the small changes in concentrations and the easy compliance with limit values, a rating of negligible would be expected for all pollutants.

Under the 2024 DS scenario, all predicted pollutant concentrations comply with the relevant limit values at all worst-case receptors selected. Following guidance provided in LAQM.TG16 [7], as all modelled results predict annual mean concentrations less than 60µg/m³, it is unlikely that this area would exceed the hourly mean NO_2 objective.

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[7] Defra (2016) Local Air Quality Management Technical Guidance TG16

It should also be noted that predicted concentrations comply with the PM_{10} WHO guideline values at all locations.

The WHO $PM_{2.5}$ annual mean limit of 10µg/m^3 is exceeded for the DM and DS scenarios with the background level in excess of this guideline level.

Table 16.21: Predicted Pollutant Concentrations Including Background Concentrations 2024

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
R01	DN	10.72	17.1	9.7	<1	344.4	0.41
	DS	10.72	17.2	9.8	<1	345.9	0.42
	DS – DN	0	0.1	0.1	0	1.5	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R02	DN	14.22	17.1	10.6	<2	380.9	0.46
	DS	14.22	17.2	10.6	<2	383.5	0.47
	DS – DN	0	0.1	0	0	2.6	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R03	DN	11.72	17.1	10	<1	367.9	0.45
	DS	11.92	17.2	10.1	<1	374.1	0.47
	DS – DN	0.2	0.1	0.1	0	6.2	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R04	DN	11.12	17.1	9.9	<1	365.1	0.44
	DS	11.42	17.2	10	<1	371.7	0.45
	DS – DN	0.3	0.1	0.1	0	6.6	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R05	DN	9.52	17.1	9.5	<1	336.7	0.4
	DS	9.72	17.2	9.6	<1	343.8	0.41
	DS – DN	0.2	0.1	0.1	0	7.1	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R06	DN	11.92	17.1	10.1	<1	376.6	0.45
	DS	12.82	17.5	10.5	<2	393.7	0.48
	DS – DN	0.9	0.4	0.4	1	17.1	0.03

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R07	DN	12.22	17.1	10.3	<2	369	0.44
	DS	13.32	17.4	10.6	<2	373.9	0.44
	DS – DN	1.1	0.3	0.3	0	4.9	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R08	DN	12.92	17.1	10.4	<2	368.5	0.44
	DS	13.22	17.2	10.5	<2	370.5	0.44
	DS – DN	0.3	0.1	0.1	0	2	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R09	DN	11.12	17.1	9.9	<1	365.1	0.44
	DS	11.42	17.2	10	<1	371.7	0.45
	DS – DN	0.3	0.1	0.1	0	6.6	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R10	DN	9.42	17.1	9.7	<1	335.5	0.4
	DS	10.72	17.5	10	<1	363.7	0.44
	DS – DN	1.3	0.4	0.3	0	28.2	0.04
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R11	DN	9.52	17.1	9.7	<1	336.4	0.4
	DS	11.82	17.8	10.3	<2	369.4	0.44
	DS – DN	2.3	0.7	0.6	0	33	0.04
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R12	DN	9.62	17.1	9.7	<1	338.1	0.41
	DS	12.22	18	10.5	<2	378.1	0.45
	DS – DN	2.6	0.9	0.8	0	40	0.04
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R13	DN	11.32	17.1	10.1	<1	384.5	0.46
	DS	11.92	17.3	10.3	<2	395.4	0.48
	DS – DN	0.6	0.2	0.2	0	10.9	0.02

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R14	DN	12.22	17.1	10.2	<2	377.5	0.46
	DS	14.02	17.7	10.7	<2	400.2	0.49
	DS – DN	1.8	0.6	0.5	0	22.7	0.03
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R15	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.22	17.9	10.2	<1	352.7	0.43
	DS – DN	1.9	0.8	0.7	0	19.7	0.03
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R16	DN	9.32	17.1	9.5	<1	333	0.4
	DS	13.92	18.9	11.1	<2	383	0.49
	DS – DN	4.6	1.8	1.6	0	50	0.09
	Impact Rating	Slight Adverse	Negligible	Negligible	n/a	n/a	n/a
R17	DN	9.32	17.1	9.5	<1	333	0.4
	DS	14.42	19.2	11.3	<3	387.2	0.48
	DS – DN	5.1	2.1	1.8	0	54.2	0.08
	Impact Rating	Slight Adverse	Negligible	Negligible	n/a	n/a	n/a
R18	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.22	17.7	10	<1	349.1	0.42
	DS – DN	1.9	0.6	0.5	0	16.1	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R19	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.32	17.4	9.7	<1	348.9	0.42
	DS – DN	1	0.3	0.2	0	15.9	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R20	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.22	17.7	10	<1	370.6	0.44
	DS – DN	1.9	0.6	0.5	0	37.6	0.04

Receptor	**Scenario**	**NO_2 (µg/m³)**	**PM_{10} (µg/m³)**	**$PM_{2.5}$ (µg/m³)**	**PM_{10} (Days > 50 µg/m³)**	**CO (µg/m³)**	**Benzene (µg/m³)**
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R21	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.52	17.4	9.7	<1	345.3	0.41
	DS – DN	1.2	0.3	0.2	0	12.3	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R22	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.92	19.1	10.1	<1	363.1	0.43
	DS – DN	2.6	2	0.6	0	30.1	0.03
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R23	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.92	17.5	9.8	<1	349.6	0.42
	DS – DN	1.6	0.4	0.3	0	16.6	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R24	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.92	17.5	9.8	<1	349.8	0.42
	DS – DN	1.6	0.4	0.3	0	16.8	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R25	DN	9.32	17.1	11.2	<1	333	0.4
	DS	11.12	17.6	11.6	<1	352.1	0.42
	DS – DN	1.8	0.5	0.4	0	19.1	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R26	DN	10.02	17.1	9.7	<1	338.1	0.4
	DS	10.12	17.1	9.7	<1	338.3	0.4
	DS – DN	0.1	0	0	0	0.2	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R27	DN	13.42	17.1	11.4	<3	371.9	0.46
	DS	13.52	17.2	11.4	<3	372.8	0.46
	DS – DN	0.1	0.1	0	0	1	0

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R28	DN	10.62	17.1	9.9	<1	342.3	0.41
	DS	10.72	17.2	10	<1	342.9	0.41
	DS – DN	0.1	0.1	0.1	0	0.6	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a

Design Year (2039)

Predicted concentrations (including background concentrations) for the 'DM', and 'DS' scenarios for the Opening Year 2039 are presented in **Table 16.22**. The receptor where the highest concentration of pollutants are predicted (including the background concentrations) as a result of the 'DS' scenario is Receptor 17 for NO_2, PM_{10}, $PM_{2.5}$, CO and Benzene (refer to **Figure 16.1.1**).

For this receptor, annual average concentrations of NO_2 are predicted to be 14.72µg/m³, which complies with the AQS of 40µg/m³; annual average concentrations of $PM_{2.5}$ are predicted to be 11.4µg/m³, which complies with the proposed limit value of 25µg/m³ and the annual average concentrations of PM_{10} are predicted to be 19.3µg/m³ which complies with the limit value of 40µg/m³. The number of annual days which PM_{10} levels is predicted to exceed the limit of 50µg/m³ is <3 days. This complies with the limit of 35 days. Annual average concentrations of Benzene are predicted to be 0.5µg/m³, which complies with the AQS of 5µg/m³ and 8 hour concentrations of CO are predicted to be 390.9µg/m³, which complies with the AQS of 10,000µg/m³.

From **Tables 16.4**, **16.5** and **16.6**, the predicted changes in concentration of all pollutants are rated as negligible or imperceptible impacts at all receptors except at receptors, R17 and R16 where an impact of slight adverse is predicted for NO_2. No impact rating is provided for benzene or CO in the TII Guidance. However, due to the small changes in concentrations and the easy compliance with limit values, a rating of negligible would be expected for all pollutants. The increase in magnitude of change in PM_{10} daily values is also considered negligible.

Under the 2039 DS scenario, all predicted pollutant concentrations comply with the relevant limit values at all receptors selected. Following guidance provided in LAQM.TG16[8], as all modelled results predict annual mean concentrations less than 60µg/m³, it is unlikely that this area would exceed the hourly mean NO_2 objective.

[8] Defra (2016) Local Air Quality Management Technical Guidance TG16

It should also be noted that predicted concentrations comply with the PM_{10} WHO guideline values at all locations.

The WHO $PM_{2.5}$ annual mean limit of 10µg/m^3 is exceeded for the DM and DS scenarios at some of the receptors with the background level of 9.5µg/m^3 close to this guideline level.

At the entrance and exit to the Lackagh Tunnel at Ch. 11+150, the closest residential receptors are approximately 470m from the eastern entrance and 480m from the western entrance. No significant air quality impacts are envisaged at these locations due to the separation from the tunnel openings to the nearest receptors.

At the entrance and exit to the tunnel at the Galway Racecourse, the closest sensitive receptors are approximately 80m from the eastern entrance and 350m from the western entrance. No significant air quality impacts are envisaged at these locations due to the separation from the tunnel openings to the nearest receptors.

Table 16.22: Predicted Pollutant Concentrations Including Background Concentrations – 2039

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
R01	DN	10.92	17.1	9.8	<1	345.6	0.5
	DS	11.02	17.2	9.8	<1	347.7	0.5
	DS- DN	0.1	0.1	0	0	2.1	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R02	DN	14.72	17.1	10.7	<2	382.3	0.5
	DS	14.52	17.1	10.7	<2	384.2	0.5
	DS- DN	-0.2	0	0	0	1.9	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R03	DN	11.92	17.1	10	<1	367.7	0.5
	DS	12.12	17.2	10.1	<1	374.8	0.5
	DS- DN	0.2	0.1	0.1	0	7.1	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R04	DN	11.42	17.1	10	<1	370.5	0.5
	DS	11.72	17.2	10.1	<1	378.2	0.5
	DS- DN	0.3	0.1	0.1	0	7.7	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R05	DN	9.52	17.1	9.5	<1	337.3	0.4
	DS	9.82	17.2	9.6	<1	344.8	0.5

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	DS- DN	0.3	0.1	0.1	0	7.5	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R06	DN	12.52	17.1	10.2	<2	382.5	0.5
	DS	13.02	17.5	10.5	<2	395.8	0.5
	DS- DN	0.5	0.4	0.3	0	13.3	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R07	DN	12.72	17.1	10.5	<2	371.3	0.5
	DS	12.82	17.1	10.5	<2	374.3	0.5
	DS- DN	0.1	0	0	0	3	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R08	DN	12.92	17.1	10.4	<2	368.6	0.5
	DS	13.32	17.2	10.5	<2	370.8	0.5
	DS- DN	0.4	0.1	0.1	0	2.2	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R09	DN	11.42	17.1	10	<1	370.5	0.5
	DS	11.72	17.2	10.1	<1	378.2	0.5
	DS- DN	0.3	0.1	0.1	0	7.7	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R10	DN	9.52	17.1	9.7	<1	335.9	0.4
	DS	11.02	19.05	10.1	<1	367.4	0.5
	DS- DN	1.5	1.95	0.4	0	31.5	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R11	DN	9.52	17.1	9.7	<1	336.5	0.4
	DS	12.22	17.9	10.4	<2	373.1	0.5
	DS- DN	2.7	0.8	0.7	0	36.6	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R12	DN	9.62	17.1	9.7	<1	338.3	0.4
	DS	12.92	18.2	10.7	<2	389.4	0.5
	DS- DN	3.3	1.1	1	0	51.1	0.1

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R13	DN	11.42	17.1	10.1	<2	386.6	0.5
	DS	12.12	17.3	10.3	<2	398.8	0.5
	DS- DN	0.7	0.2	0.2	0	12.2	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R14	DN	12.32	17.1	10.2	<1	378.1	0.5
	DS	14.62	17.9	10.9	<1	407	0.5
	DS- DN	2.3	0.8	0.7	0	28.9	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R15	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.42	17.7	10	<1	354.2	0.5
	DS- DN	2.1	0.6	0.5	0	21.2	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R16	DN	9.32	17.1	9.5	<1	333	0.4
	DS	14.32	19	11.2	<2	383	0.5
	DS- DN	5	1.9	1.7	0	50	0.1
	Impact Rating	Slight Adverse	Negligible	Negligible	n/a	n/a	n/a
R17	DN	9.32	17.1	9.5	<1	333	0.4
	DS	14.72	19.3	11.4	<3	390.9	0.5
	DS- DN	5.4	2.2	1.9	0	57.9	0.1
	Impact Rating	Slight Adverse	Negligible	Negligible	n/a	n/a	n/a
R18	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.42	17.8	10.1	<1	351.5	0.5
	DS- DN	2.1	0.7	0.6	0	18.5	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R19	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.42	17.4	9.7	<1	350	0.5
	DS- DN	1.1	0.3	0.2	0	17	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
R20	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.42	17.8	10	<1	375.6	0.5
	DS- DN	2.1	0.7	0.5	0	42.6	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R21	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.62	17.4	9.7	<1	346	0.5
	DS- DN	1.3	0.3	0.2	0	13	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R22	DN	9.32	17.1	9.5	<1	333	0.4
	DS	12.02	17.9	10.2	<2	364.7	0.5
	DS- DN	2.7	0.8	0.7	0	31.7	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R23	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.02	17.6	9.8	<1	350.5	0.5
	DS- DN	1.7	0.5	0.3	0	17.5	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R24	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.12	17.6	9.9	<1	352.8	0.5
	DS- DN	1.8	0.5	0.4	0	19.8	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R25	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.32	17.7	10	<1	355.6	0.5
	DS- DN	2	0.6	0.5	0	22.6	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R26	DN	10.22	17.1	9.8	<1	339.4	0.4
	DS	10.32	17.1	9.8	<1	339.7	0.4
	DS- DN	0.1	0	0	0	0.3	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R27	DN	13.82	17.1	11.6	<3	376.5	0.5
	DS	13.92	17.2	11.7	<3	377.5	0.5

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	DS- DN	0.1	0.1	0.1	0	1	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R28	DN	10.82	17.1	10	<1	343.2	0.5
	DS	10.92	17.2	10	<1	344.2	0.5
	DS- DN	0.1	0.1	0	0	1	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a

Ecologically Sensitive Areas

Lough Corrib cSAC

The following sections assess the potential for pollution due to the proposed road development under the headings of nitrogen compounds, VOC, metals/dust and ammonia at the Lough Corrib cSAC, at the River Corrib Bridge between Ch. 9+250 and Ch. 9+600, between Ch. 9+800 and Ch. 10+100 at Menlough, and Lackagh Tunnel between Ch. 10+450 and Ch. 11+450 during the operational phase, refer to **Figures 8.15.7** and **8.15.8**.

NOx

Table 16.23 presents the results from the air quality modelling using DMRB methodology based on traffic volumes for 2024 (Year of Opening) and 2039 (Design Year) for the Do-Minimum (without the proposed road development) and Do-Something (with the proposed road development) scenarios at the section of road at the Lough Corrib cSAC. The potential impact of NO_x concentration and deposition was assessed at various distances from the edge of the proposed road. The assessment was carried out in accordance with TII Guidelines using the DMRB Screening Model. Background concentrations are as outlined in **Table 16.19**.

Ambient NO_x concentrations predicted for the Opening and Design Years along a transect of up to 200m from the centre of the proposed road development are given in **Table 16.23** in accordance with TII guidance. The contribution of the proposed road development to NO_x deposition is also given and was calculated using the TII guidance methodology.

The annual average NO_x concentration at various distances from the centre of the road complies with the limit value of 30 µg/m³ for the Do-Minimum scenario in 2024 and 2039, with NO_x concentrations reaching 37% of this limit in 2024 and 2039. For the Do-Something scenario, the limit values are complied with in 2024 at 80% of the limit value and complied with in 2039 with the predicted concentration at 83% of the limit value, including background concentrations at 10m from the edge of the proposed road.

The potential impact of the proposed road development results in a maximum increase in NO_x concentrations of a maximum of 13.64μg/m^3 at 10m from the proposed road edge. All predicted concentrations are in compliance with the Air Quality Standard for the protection of vegetation.

The proposed road development contribution to the NO_2 dry deposition rate along the 200m transect from the proposed road edge is also detailed in **Table 16.23**. The maximum increase in the NO_2 dry deposition rate is 1.03kg(N)/ha/yr in 2024 and 1.06kg(N)/ha/yr in 2039 for the Do-Something scenario. This is approximately 20% of the critical load for the lower boundary limit of inland and surface water habitats of 5-10kg(N)/ha/yr (TII 2011).

As outlined in **Section 16.3.2**, background nitrogen deposition levels are likely in the range of 1 to 2.5kg(N)/ha/yr. The addition of these background levels results in continued compliance with the critical load.

Table 16.23: Predicted Nitrogen Concentration including Background and Deposition at the Lough Corrib cSAC for 2024 and 2039

Distance to Proposed Road Development (m)	NOx Concentration (µg/m^3) 2024				NOx Concentration (µg/m^3) 2039			NO_2 Dry Deposition Rate Impact (kg(N)/ha/yr)	
	Background	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase	2024	2039
10	11.2	11.2	23.97	12.77	11.2	24.84	13.64	1.03	1.06
20	11.2	11.2	21	9.8	11.2	21.67	10.47	0.95	0.97
30	11.2	11.2	18.83	7.63	11.2	19.35	8.15	0.88	0.89
40	11.2	11.2	17.19	5.99	11.2	17.6	6.4	0.82	0.84
50	11.2	11.2	15.92	4.72	11.2	16.25	5.05	0.78	0.79
60	11.2	11.2	14.92	3.72	11.2	15.18	3.98	0.74	0.75
70	11.2	11.2	14.13	2.93	11.2	14.33	3.13	0.71	0.72
80	11.2	11.2	13.49	2.29	11.2	13.65	2.45	0.69	0.69
90	11.2	11.2	12.99	1.79	11.2	13.11	1.91	0.67	0.67
100	11.2	11.2	12.6	1.4	11.2	12.69	1.49	0.65	0.65
110	11.2	11.2	12.29	1.09	11.2	12.36	1.16	0.64	0.64
120	11.2	11.2	12.06	0.86	11.2	12.12	0.92	0.63	0.63
130	11.2	11.2	11.9	0.7	11.2	11.94	0.74	0.62	0.62

Distance to Proposed Road Development (m)	NOx Concentration (μg/m³) 2024				NOx Concentration (μg/m³) 2039			NO_2 Dry Deposition Rate Impact (kg(N)/ha/yr)	
	Background	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase	2024	2039
140	11.2	11.2	11.79	0.59	11.2	11.83	0.63	0.61	0.62
150	11.2	11.2	11.73	0.53	11.2	11.77	0.57	0.61	0.61
160	11.2	11.2	11.7	0.5	11.2	11.74	0.54	0.61	0.61
170	11.2	11.2	11.62	0.42	11.2	11.65	0.45	0.6	0.61
180	11.2	11.2	11.54	0.34	11.2	11.56	0.36	0.6	0.6
190	11.2	11.2	11.46	0.26	11.2	11.48	0.28	0.6	0.6
200	11.2	11.2	11.38	0.18	11.2	11.39	0.19	0.6	0.6
Standards	**30μg/m³**	**30μg/m³**	**30μg/m³**		**30μg/m³**	**30μg/m³**		**5-10kg(N)/ha/yr**	

VOC

No critical load limits exist for VOCs for the protection of vegetation.

An assessment of emissions of benzene was carried out for the proposed road development, in accordance with TII methodology using the DMRB modelling spreadsheet. Predicted concentrations were compared to the air quality standard of 5µg/m^3 for the protection of human health. The maximum predicted concentration for the Do-Something scenario was 10.2% of the standard including background concentrations of 5µg/m^3. As stated previously, these limits have been developed to protect the environment as a whole.

Benzene concentrations predicted for the Opening and Design Years along a transect of up to 200m from the proposed road development are given in **Table 16.24**.

Table 16.24: Predicted Benzene concentrations at the Lough Corrib cSAC including Background Concentrations for 2024 and 2039

Distance to Proposed Road Development (m)	Benzene Concentration (µg/m^3) 2024			Benzene Concentration (µg/m^3) 2039		
	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase
10	0.4	0.49	0.09	0.4	0.51	0.11
20	0.4	0.47	0.07	0.4	0.48	0.08
30	0.4	0.46	0.06	0.4	0.46	0.06
40	0.4	0.44	0.04	0.4	0.45	0.05
50	0.4	0.43	0.03	0.4	0.44	0.04
60	0.4	0.43	0.03	0.4	0.43	0.03
70	0.4	0.42	0.02	0.4	0.42	0.02
80	0.4	0.42	0.02	0.4	0.42	0.02
90	0.4	0.41	0.01	0.4	0.42	0.02
100	0.4	0.41	0.01	0.4	0.41	0.01
110	0.4	0.41	0.01	0.4	0.41	0.01
120	0.4	0.41	0.01	0.4	0.41	0.01
130	0.4	0.4	0	0.4	0.41	0.01
140	0.4	0.4	0	0.4	0.4	0
150	0.4	0.4	0	0.4	0.4	0
160	0.4	0.4	0	0.4	0.4	0
170	0.4	0.4	0	0.4	0.4	0
180	0.4	0.4	0	0.4	0.4	0
190	0.4	0.4	0	0.4	0.4	0
200	0.4	0.4	0	0.4	0.4	0

Distance to Proposed Road Development (m)	**Benzene Concentration (µg/m³) 2024**			**Benzene Concentration (µg/m³) 2039**		
	Do-Minimum	**Do-Something**	**Increase**	**Do-Minimum**	**Do-Something**	**Increase**
Standards	**5µg/m³**	**5µg/m³**		**5µg/m³**	**5µg/m³**	

As outlined in **Section 16.2.5**, the Natural England report states that *levels of ethylene likely to be found in the vicinity of roads may be high enough to adversely affect sensitive species*. On this basis, comparisons of emission factors of VOCs (mg/vehicle/km) have been examined in order to estimate an appropriate ratio of ethylene to benzene. The five studies examined[9]; various types of vehicles, over a ten year period, across three countries. The highest ratio of ethylene to benzene determined was 3:1, for vehicles which were primarily diesel emissions. Increases in ethylene from the proposed road development have been predicted using this ratio and results presented in **Table 16.25**. No background data or relevant limit values are available for ethylene. At 10m from the proposed road edge a 0.28µg/m³ increase is predicted in 2024 and a 0.33µg/m³ increase in 2039.

Table 16.25: Predicted ethylene concentrations at the Lough Corrib cSAC for 2024 and 2039

Distance to Proposed Road Development (m)	**Ethylene Concentration (µg/m³) 2024**	**Ethylene Concentration (µg/m³) 2039**
	Increase	**Increase**
10	0.28	0.33
20	0.22	0.25
30	0.17	0.19
40	0.13	0.15
50	0.10	0.12
60	0.08	0.09
70	0.06	0.07
80	0.05	0.06
90	0.04	0.05
100	0.03	0.04
110	0.02	0.03
120	0.02	0.02
130	0.03	0.02
140	0.03	0.03
150	0.03	0.03

[9] Atmospheric Chemistry and Physics, 2009. *Vehicular emission of volatile organic compounds (VOCs) from a tunnel in Hong Kong*). Available at http://www.klacp.ac.cn/kycg/scilw/201506/W020150612344767439939.pdf

Distance to Proposed Road Development (m)	Ethylene Concentration (μg/m^3) 2024	Ethylene Concentration (μg/m^3) 2039
	Increase	Increase
160	0.03	0.03
170	0.03	0.03
180	0.03	0.03
190	0.03	0.03
200	0.03	0.03

Metals/Dust

No critical load limits exist for metals or dust for the protection of vegetation.

As outlined in the Environmental Protection Agency Air Quality in Ireland report 2015, high levels of heavy metals are usually observed in areas with a lot of heavy industry such as smelting and mining. Ireland as a country which has few heavy industries such as these, and as a consequence, the concentration of heavy metals is likely to remain low in the future. No reference is made to high levels of metals due to traffic emissions.

Heavy metals are continually monitored by the EPA for Zone C, at the heavily trafficked Bodkin Junction, Galway. Since 2015 measured heavy metals (Lead, Arsenic, Cadmium and Nickel) are all well below target values i.e. Lead 0.7%, Arsenic 15%, Cadmium 6%, Nickel 3% of the target values (Directive 2004/107/EC). These limits were developed to protect the environment as a whole.

PM_{10} concentrations predicted for the Opening and Design Years along a transect of up to 200m from the proposed road development are given in **Table 16.26**. Values include background concentrations of 17.1μg/m^3. All predicted concentrations are in compliance with the air quality standard for PM_{10} of 40μg/m^3. A maximum increase of 1.89μg/m^3 is predicted to occur in 2039 at 10m from the proposed road edge.

Table 16.26: Predicted PM_{10} concentrations at the Lough Corrib cSAC including Background Concentrations for 2024 and 2039

Distance to Proposed Road Development (m)	PM_{10} Concentration (μg/m^3) 2024			PM_{10} Concentration (μg/m^3) 2039		
	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase
10	17.1	18.86	1.76	17.1	18.99	1.89
20	17.1	18.45	1.35	17.1	18.55	1.45
30	17.1	18.15	1.05	17.1	18.23	1.13
40	17.1	17.93	0.83	17.1	17.99	0.89
50	17.1	17.75	0.65	17.1	17.8	0.7
60	17.1	17.61	0.51	17.1	17.65	0.55

Distance to Proposed Road Development (m)	PM_{10} Concentration (µg/m^3) 2024			PM_{10} Concentration (µg/m^3) 2039		
	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase
70	17.1	17.5	0.4	17.1	17.53	0.43
80	17.1	17.42	0.32	17.1	17.44	0.34
90	17.1	17.35	0.25	17.1	17.37	0.27
100	17.1	17.29	0.19	17.1	17.31	0.21
110	17.1	17.25	0.15	17.1	17.26	0.16
120	17.1	17.22	0.12	17.1	17.23	0.13
130	17.1	17.2	0.1	17.1	17.2	0.1
140	17.1	17.18	0.08	17.1	17.19	0.09
150	17.1	17.17	0.07	17.1	17.18	0.08
160	17.1	17.17	0.07	17.1	17.17	0.07
170	17.1	17.16	0.06	17.1	17.16	0.06
180	17.1	17.15	0.05	17.1	19.05	1.95
190	17.1	17.14	0.04	17.1	17.14	0.04
200	17.1	17.12	0.02	17.1	17.12	0.02
Standards	**40µg/m^3**	**40µg/m^3**	**40µg/m^3**	**40µg/m^3**	**40µg/m^3**	**40µg/m^3**

Ammonia

As outlined earlier, ammonia is emitted in small amounts by vehicles with catalytic converters and *roadside atmospheric concentrations are well below critical levels* for this pollutant. The Natural England report states that it is *unlikely to be a key issue, and effects on vegetation are more likely to arise from enhanced deposition of nitrogen to the soil environment*. The potential impact of nitrogen deposition on ecological sites has been assessed earlier in this Section.

River Corrib Bridge Crossing

The proposed road development crosses the River Corrib which is within the Lough Corrib cSAC on a bridge and embankment (between Ch. 9+500 and Ch. 9+600).

Noise barriers are proposed on both sides of the bridge structure. These will contain the majority of pollutants generated by traffic accessing the proposed road development. The elevated position of the proposed road development at this location will also result in good dispersion of pollution generated from traffic. This will have the effect of significantly lowering ground level concentrations. In addition, predicted concentrations of NO_x and nitrogen deposition levels are below relevant limits at this location even within 10m from the proposed road edge, refer to **Table 16.23**.

Predicted concentrations of VOCs and dust are in compliance with air quality standards for the protection of the environment as a whole.

Menlough – Ch. 9+800 to 10+100

To the east of the River Corrib the proposed road development continues east on embankment toward the Menlough Viaduct and traverses outside of the boundary of the Lough Corrib cSAC, overlapping it in places. The ecologically sensitive area where the qualifying interests of the Lough Corrib cSAC are located is to the southeast of this section of the proposed road development and comprises of an area of semi-natural Oak-Ash-Hazel woodlands, scrub, wet grassland and calcareous grassland; some of which correspond to Qualifying Interest (QI) Annex I habitats.

The elevated position of the proposed road development at this location will result in good dispersion of pollution generated from traffic. In addition, predicted concentrations of NO_x and nitrogen deposition levels are predicted to be below relevant limits at this location even within 10m of the proposed road edge.

Predicted concentrations of VOCs and dust are in compliance with air quality standards for the protection of the environment as a whole.

A windrose for Athenry meteorological station is provided in **Plate 16.3** (www.met.ie). This demonstrates that the prevailing wind in the area is from the south-west and west. The wind directions required to direct pollution towards this sensitive area are from the northwest and west. According to the windrose, wind from the northwest in 2016 was recorded for approximately 7% of the time in 2016. Therefore, the likelihood of pollution generated by road traffic interacting with the sensitive area is low due to northwest winds. Westerly winds were recorded for approximately 15% of the time in 2016. However, for approximately 10% of this time the wind speeds recorded are greater than 5 knots. This results in high dispersion of potential pollutants during this time, greatly reducing pollutant concentrations.

The separation between the edge of the proposed road development and the ecologically sensitive area is approximately 15m. As outlined in **Table 16.23**, the nitrogen deposition levels due to the proposed road development at such distances is predicted to be less than relevant limits.

Lackagh Tunnel

East of the Menlough Viaduct, the proposed road development enters a section of cut preceding Lackagh Tunnel immediately west of Lackagh Quarry and exits the tunnel in the disused quarry. The Lackagh Tunnel passes underneath Lough Corrib cSAC. The overlying habitats within the Lough Corrib cSAC at this location comprise a mosaic of Limestone pavement, and Calcareous grassland. All of these habitat types are Qualifying Interest (QI) habitats of the Lough Corrib cSAC.

As the proposed road development is in tunnel beneath the Lough Corrib cSAC at this location and the eastern approach is within Lackagh Quarry surrounded by quarry walls up to 40m in height, emissions generated here will not be physically able to interact with the designated areas. At the portals and at the western approach to the tunnel which runs adjacent (approximately 10m) to the Lough Corrib cSAC, there is the potential for air quality impacts. However, as outlined in **Table 16.23**, the nitrogen deposition levels due to the proposed road development at such distances is predicted to be less than relevant limits.

In addition, the dispersal of pollution at the eastern and western approach to the tunnel will be contained due to the effective barrier caused by the cutting along the Lough Corrib cSAC at this location.

Between Ch. 10+450 and Ch. 10+600 and between Ch. 10+750 and Ch. 10+900 there are short sections of embankment adjacent to the Lough Corrib cSAC. QI habitats are located c.75m from the first location (north of the proposed road development) and at the second location, c.45m from the northern edge of the proposed road development and c.15m from the southern edge of the proposed road development. At these distances of between 10 and 75m from the edge of the proposed road, NOx concentrations are predicted to be in compliance with the air quality standards for the protection of vegetation and the critical load for nitrogen deposition, refer to **Table 16.23**.

Predicted concentrations of VOCs and metals/dust are in compliance with air quality standards for the protection of the environment as a whole, refer to **Tables 16.24** and **16.25**.

Other ecological sensitive sites

Table 16.26 presents the results from the air quality modelling using DMRB methodology based on traffic volumes for 2024 (Opening Year) and 2039 (Design Year) for the Do-Minimum (without the proposed road development) and Do-Something (with the proposed road development) scenarios at the section of the proposed road development between N83 Tuam Road and N84 Headford (highest predicted traffic volumes). Lesser concentration and deposition values would be expected at all other sections of the proposed road development where lesser traffic volumes are predicted. The potential impact of NO_x concentration and deposition was assessed at various distances from the edge of the proposed road. The assessment was carried out in accordance with TII Guidelines using the DMRB Screening Model. Background concentrations are as outlined in **Table 16.19**.

The annual average NO_x concentration at various distances from the proposed road edge complies with the limit value of 30μg/m^3 for the Do-Minimum scenario in 2024 and 2039, with NO_x concentrations reaching 37% of this limit in 2024 and 2039. In the 2024 Do-Something scenario, the limit values are complied with at 86% of the limit value, this equates to a slight adverse impact. In the 2039 Do-Something scenario, the limit values are complied with at 92% of the limit value, this equates to a slight adverse impact.

Further away from the proposed road edge, all predicted concentrations comply.

The potential impact of the proposed road development results in a maximum increase in NO_x concentrations of a maximum of 16.53μg/m^3 at 10m from the proposed road edge.

The proposed road development contribution to the NO_2 dry deposition rate along the 200m transect from the proposed road edge is also detailed in **Table 16.27**. The maximum increase in the NO_2 dry deposition rate is predicted to be 1.22kg(N)/ha/yr in 2024 and 1.27kg(N)/ha/yr in 2039 for the Do-Something scenario. This is approximately 24.4% and 25.4% respectively of the critical load for the lower boundary limit of inland and surface water habitats of 5-10kg(N)/ha/yr (TII 2011).

Table 16.27: Predicted Nitrogen Concentration including background concentrations and Deposition at the section of the proposed road development with the highest AADT (between N83 and N84) for 2024 and 2039

Distance to Proposed Road Development (m)	NO_x Concentration (µg/m^3) 2024				NO_x Concentration (µg/m^3) 2039			NO_2 Dry Deposition Rate Impact (kg(N)/ha/yr)	
	Background	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase	2024	2039
10	11.2	11.2	25.87	14.67	11.2	27.73	16.53	1.22	1.27
20	11.2	11.2	22.46	11.26	11.2	23.88	12.68	1.12	1.16
30	11.2	11.2	19.97	8.77	11.2	21.08	9.88	1.04	1.08
40	11.2	11.2	18.09	6.89	11.2	18.96	7.76	0.98	1.01
50	11.2	11.2	16.63	5.43	11.2	17.31	6.11	0.93	0.96
60	11.2	11.2	15.48	4.28	11.2	16.02	4.82	0.89	0.91
70	11.2	11.2	14.56	3.36	11.2	14.99	3.79	0.86	0.88
80	11.2	11.2	13.84	2.64	11.2	14.17	2.97	0.83	0.85
90	11.2	11.2	13.26	2.06	11.2	13.52	2.32	0.81	0.82
100	11.2	11.2	12.8	1.6	11.2	13.01	1.81	0.79	0.8
110	11.2	11.2	12.45	1.25	11.2	12.61	1.41	0.77	0.78
120	11.2	11.2	12.19	0.99	11.2	12.31	1.11	0.76	0.77
130	11.2	11.2	12	0.8	11.2	12.1	0.9	0.75	0.76
140	11.2	11.2	11.88	0.68	11.2	11.96	0.76	0.75	0.75

Distance to Proposed Road Development (m)	NO_x Concentration (µg/m^3) 2024				NO_x Concentration (µg/m^3) 2039			NO_2 Dry Deposition Rate Impact (kg(N)/ha/yr)	
	Background	**Do-Minimum**	**Do-Something**	**Increase**	**Do-Minimum**	**Do-Something**	**Increase**	**2024**	**2039**
150	11.2	11.2	11.81	0.61	11.2	11.89	0.69	0.74	0.75
160	11.2	11.2	11.78	0.58	11.2	11.85	0.65	0.74	0.75
170	11.2	11.2	11.69	0.49	11.2	11.75	0.55	0.74	0.74
180	11.2	11.2	11.59	0.39	11.2	11.64	0.44	0.73	0.74
190	11.2	11.2	11.5	0.3	11.2	11.54	0.34	0.73	0.73
200	11.2	11.2	11.4	0.2	11.2	11.3	0.1	0.72	0.72
Standards	**30µg/m^3**	**30µg/m^3**	**30µg/m^3**		**30µg/m^3**	**30µg/m^3**		**5-10kg(N)/ha/yr**	

Air Quality Improvements

Table 16.28 outlines locations where air quality will improve as a result of decreases in AADT. Light green areas represent scenarios where AADT flow values will decrease by 10%, the darkest green represents up to an 80% decrease.

The reduction in traffic will result in a localised improvement of air quality in these regions, which will be particularly evident where sensitive receptors are adjacent to roadways and traffic reductions are substantial.

Table 16.28: Locations of Improved Air Quality as a result of reduced AADT flows (refer to Figure 6.9 for location of link numbers)

Link number	Link location	2024	2039
		DS-DM	DS-DM
4	Existing N6 South of Briarhill	42%	40%
5	Existing N6 Near Ballybrit Business park	46%	39%
6	Existing N6 between N83 and R865	33%	30%
7	Existing N6 Between N84 and N83	50%	45%
9	Existing N6 - On Quincentenary Bridge	30%	30%
10	R338 at Westside Playing fields	50%	46%
11	Western Distributor Rd between Clybaun Rd and R338	35%	31%
12	Western Distributor Rd between Clybaun Rd and Ballymoneen Rd	21%	20%
13	R337 Kingston Road. Kingston	40%	40%
14	R336. Salthill Road Upper. Galway Golf Course	17%	18%
15	R336. Bearna Road. Bearna Woods	73%	73%
16	R336. Bearna Road. Bearna. Creagan bus stop	75%	77%
19	Boleybeg Road. Between Cappagh Road and Ballymoneen Road	67%	63%
21	N59. Thomas Hynes road. Between Hazel Park and Cherry Park	25%	21%
22	N59. Upper Newcastle Road. Between R338 and Corrib Village	18%	17%
23	N59. Barnacranny. Between Chesnut Lane and Circular Rd	19%	19%
29	R336. Tuam Road. Mervue Business Park	25%	24%
30	Wolfe Tone Bridge	20%	20%
32	Salmon Weir Bridge	15%	19%
34	Eglington Street	12%	15%
37	Cappagh Road - North of the proposed road development	52%	53%

16.5.4.2 Local air quality impacts based on ADMS model

NO_2

Annual mean NO_2 concentrations were predicted at the receptor locations for the future year when the proposed road development Opens (2024) and the Design Year (2039). It should be noted that this has been undertaken retaining vehicle emission factors and background pollutant concentrations at baseline levels (**Table 16.19**) to represent a worst case scenario.

Predicted annual mean NO_2 concentrations for the Do-Minimum (without the proposed road development) and Do-Something (with the proposed road development), the change in concentrations as a result of the proposed road development and the impact descriptor at each receptor are shown in **Table 16.29** and **Table 16.30** for the Opening Year (2024) and Design Year (2039), respectively. Results of modelling with the noise barriers in place area also included for the receptors, where relevant.

Table 16.29: Predicted concentrations of NO_2 ($\mu g/m^3$), 2024

Receptor	Do-Nothing ($\mu g/m^3$)	Without noise barriers			With noise barriers		
		Do-Something ($\mu g/m^3$)	Change in NO_2 ($\mu g/m^3$)	Impact	Do-Something ($\mu g/m^3$)	Change in NO_2 ($\mu g/m^3$)	Impact
R01	10	10.5	0.5	Negligible	-	-	-
R02	14.6	15.3	0.7	Negligible	-	-	-
R03	12	13	1	Negligible	-	-	-
R04	10.6	11.3	0.7	Negligible	11.3	0.7	Negligible
R05	8.9	9.2	0.3	Negligible	-	-	-
R06	12.1	15.2	3.1	Negligible	15.2	3.1	Negligible
R07	11.9	12.6	0.7	Negligible	-	-	-
R08	11.7	12.2	0.5	Negligible	-	-	-
R09	10.3	10.6	0.3	Negligible	-	-	-
R10	8.9	10.9	2	Negligible	-	-	-
R11	8.8	11.5	2.7	Negligible	11.1	2.3	Negligible
R12	9	10.8	1.8	Negligible	10.8	1.8	Negligible
R13	11.7	12.1	0.4	Negligible	-	-	-
R14	13.5	13.8	0.3	Negligible	-	-	-
R15	9.4	10.6	1.2	Negligible	10.6	1.2	Negligible
R16	9	16.4	7.4	Slight adverse	15	6	Slight adverse
R17	9.2	14.7	5.5	Slight adverse	13.5	4.3	Slight adverse
R18	9.2	10.2	1	Negligible	-	-	-
R19	8.8	10	1.2	Negligible	-	-	-
R20	8.8	12.6	3.8	Negligible	12.2	3.4	Negligible

Receptor	Do-Nothing ($\mu g/m^3$)	Without noise barriers			With noise barriers		
		Do-Something ($\mu g/m^3$)	Change in NO_2 ($\mu g/m^3$)	Impact	Do-Something ($\mu g/m^3$)	Change in NO_2 ($\mu g/m^3$)	Impact
R21	8.8	9.8	1	Negligible	9.8	1	Negligible
R22	8.8	11.3	2.5	Negligible	11	2.2	Negligible
R23	8.8	9.9	1.1	Negligible	9.9	1.1	Negligible
R24	8.7	9.7	1	Negligible	9.6	0.9	Negligible
R25	8.7	9.8	1.1	Negligible	9.7	1	Negligible
R26	9.8	9.8	0	Negligible	-	-	-
R27	13.4	13.7	0.3	Negligible	-	-	-
R28	10.7	10.8	0.1	Negligible	-	-	-

Predicted annual mean concentrations are all well below the limit value (40µg/m^3). The maximum concentration was predicted at R16 (16.4µg/m^3 in 2024), where the maximum change in concentration (7.4µg/m^3) was predicted. The predicted impact at R16 can be therefore described as slight adverse, refer to **Tables 16.4**, **16.5** and **16.6**. A slight adverse impact was also predicted at R17. A negligible impact was predicted at all other locations.

With the proposed noise barriers in place, lower concentrations are predicted at all of the nearby receptors, excluding R04, R06, R12, R15, R21 and R23, where the difference in predicted concentrations is <0.01µg/m^3. The trend for lower concentrations near to the proposed road development with the noise barrier in place is expected, but the impact will depend on the orientation of the noise barrier with respect to the wind direction. At all locations, the lower predicted change in concentrations with the noise barriers in place does not change the impact descriptor.

Following guidance provided in LAQM.TG16[10], as all modelled results predict annual mean concentrations less than 60µg/m^3, it is unlikely that this area would exceed the hourly mean NO_2 objective.

Table 16.30: Predicted concentrations of NO_2 (µg/m^3), 2039

Receptor	Do-Nothing ($\mu g/m^3$)	Without noise barriers)			With noise barriers		
		Do-Something ($\mu g/m^3$)	Change in NO_2 ($\mu g/m^3$)	Impact	Do-Something ($\mu g/m^3$)	Change in NO_2 ($\mu g/m^3$)	Impact
R01	10.7	11.9	1.2	Negligible	-	-	-
R02	15.9	16.6	0.7	Negligible	-	-	-
R03	12.9	14.3	1.4	Negligible	-	-	-
R04	11.7	12.5	0.8	Negligible	12.5	0.8	Negligible
R05	9.6	10	0.4	Negligible	-	-	-

[10] Defra (2016) Local Air Quality Management Technical Guidance TG16

Receptor	Do-Nothing (µg/m³)	Without noise barriers)			With noise barriers		
		Do-Something (µg/m³)	Change in NO_2 (µg/m³)	Impact	Do-Something (µg/m³)	Change in NO_2 (µg/m³)	Impact
R06	13.4	15.4	2	Negligible	15.4	2	Negligible
R07	12.9	13.7	0.8	Negligible	-	-	-
R08	12.4	13.2	0.8	Negligible	-	-	-
R09	11.3	11.7	0.4	Negligible	-	-	-
R10	9.7	11.9	2.2	Negligible	-	-	-
R11	9.5	12.7	3.2	Negligible	12.2	2.7	Slight adverse
R12	9.7	11.9	2.2	Negligible	11.9	2.2	Slight adverse
R13	12.8	13.3	0.5	Negligible	-	-	-
R14	14.7	15.8	1.1	Negligible	-	-	-
R15	10.1	11.8	1.7	Negligible	11.8	1.7	Negligible
R16	9.7	18.2	8.5	Slight adverse	16.5	6.8	Moderate adverse
R17	10	16.6	6.6	Slight adverse	15.1	5.1	Moderate adverse
R18	9.9	11.2	1.3	Negligible	-	-	-
R19	9.5	10.9	1.4	Negligible	-	-	-
R20	9.5	14.1	4.6	Slight adverse	13.6	4.1	Slight adverse
R21	9.5	10.7	1.2	Negligible	10.6	1.1	Negligible
R22	9.5	12.5	3	Negligible	12.1	2.6	Slight adverse
R23	9.5	10.8	1.3	Negligible	10.8	1.3	Negligible
R24	9.4	10.6	1.2	Negligible	10.5	1.1	Negligible
R25	9.4	10.7	1.3	Negligible	10.6	1.2	Negligible
R26	10.9	11.1	0.2	Negligible	-	-	-
R27	15.7	16	0.3	Negligible	-	-	-
R28	12.1	12.4	0.3	Negligible	-	-	-

Predicted annual mean concentrations are all well below the limit value (40µg/m³). The maximum concentration was predicted at R16 (18.2µg/m³ in 2039), where the maximum change in concentration (8.5µg/m³) was predicted. The predicted impact at R16 can be therefore described as slight adverse, refer to **Tables 16.4**, **16.5** and **16.6**. A slight adverse impact was also predicted at R17 and R20. A negligible impact was predicted at all other locations.

With the proposed noise barriers in place, lower concentrations are predicted at all of the nearby receptors, excluding R04, R06, R12, R15 and R23, where the difference in predicted concentrations is <0.01µg/m³. The trend for lower concentrations near to the road with the noise barrier in place is expected, but the impact will depend on the orientation of the noise barrier with respect to the wind direction. At all locations, the lower predicted change in concentrations with the noise barriers in place does not change the impact descriptor.

Following guidance provided in LAQM.TG16[11], as all modelled results predict annual mean concentrations less than 60µg/m^3, it is unlikely that this area would exceed the hourly mean NO_2 objective.

PM_{10}

Annual mean PM_{10} concentrations were predicted at the assessed receptor locations for the future year when the proposed road development opens (2024) and the Design Year (2039). Although uncertainty regarding future year emission factors relates primarily to NOx emissions, it should be noted that the same approach of holding vehicle emission factors and background pollutant concentrations (**Table 16.19**) has been taken for PM_{10} and $PM_{2.5}$ concentrations.

Predicted annual mean PM_{10} concentrations for the do minimum and do something scenarios, the change in concentrations as a result of the proposed road development and the impact descriptor at each receptor are shown in **Table 16.31** and **Table 16.32**, for the Opening Year (2024) and Design Year (2039), respectively. Results of modelling with the noise barriers in place area also included for the receptors, where relevant.

Table 16.31: Predicted concentrations of PM_{10} (µg/m^3), 2024

Receptor	Do-Minimum (µg/m^3)	Without noise barriers)			With noise barriers		
		Do-Something (µg/m^3)	Change in PM_{10} (µg/m^3)	Impact	Do-Something (µg/m^3)	Change in PM_{10} (µg/m^3)	Impact
R01	17.8	17.9	0.1	Negligible	-	-	-
R02	18.6	18.7	0.1	Negligible	-	-	-
R03	18.1	18.4	0.3	Negligible	-	-	-
R04	17.9	18.1	0.2	Negligible	18.1	0.2	Negligible
R05	17.6	17.7	0.1	Negligible	-	-	-
R06	18.2	18.7	0.5	Negligible	18.7	0.5	Negligible
R07	18.2	18.4	0.2	Negligible	-	-	-
R08	18.2	18.2	0	Negligible	-	-	-
R09	17.9	17.9	0	Negligible	-	-	-
R10	17.6	18	0.4	Negligible	-	-	-
R11	17.6	18.1	0.5	Negligible	18.1	0.5	Negligible
R12	17.6	18	0.4	Negligible	18	0.4	Negligible
R13	18	18.1	0.1	Negligible	-	-	-
R14	18.4	18.5	0.1	Negligible	-	-	-

[11] Defra (2016) Local Air Quality Management Technical Guidance TG16

Receptor	Do-Minimum (µg/m³)	Without noise barriers)			With noise barriers		
		Do-Something (µg/m³)	Change in PM_{10} (µg/m³)	Impact	Do-Something (µg/m³)	Change in PM_{10} (µg/m³)	Impact
R15	17.7	18	0.3	Negligible	18	0.3	Negligible
R16	17.6	19	1.4	Negligible	18.7	1.1	Negligible
R17	17.7	18.7	1	Negligible	18.4	0.7	Negligible
R18	17.7	17.8	0.1	Negligible	-	-	-
R19	17.6	17.8	0.2	Negligible	-	-	-
R20	17.6	18.1	0.5	Negligible	18.1	0.5	Negligible
R21	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R22	17.6	18.1	0.5	Negligible	18	0.4	Negligible
R23	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R24	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R25	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R26	17.7	17.7	0	Negligible	-	-	-
R27	18	18	0	Negligible	-	-	-
R28	17.8	17.8	0	Negligible	-	-	-

Table 16.32: Predicted concentrations of PM_{10} (µg/m³), 2039

Receptor	Do-Minimum (µg/m³)	Without noise barriers)			With noise barriers		
		Do-Something (µg/m³)	Change in PM_{10} (µg/m³)	Impact	Do-Something (µg/m³)	Change in PM_{10} (µg/m³)	Impact
R01	17.8	18.1	0.3	Negligible	-	-	-
R02	18.7	18.8	0.1	Negligible	-	-	-
R03	18.2	18.4	0.2	Negligible	-	-	-
R04	18	18.1	0.1	Negligible	18.1	0.1	Negligible
R05	17.6	17.7	0.1	Negligible	-	-	-
R06	18.3	18.7	0.4	Negligible	18.7	0.4	Negligible
R07	18.3	18.4	0.1	Negligible	-	-	-
R08	18.2	18.3	0.1	Negligible	-	-	-
R09	17.9	18	0.1	Negligible	-	-	-
R10	17.6	18	0.4	Negligible	-	-	-
R11	17.6	18.2	0.6	Negligible	18.1	0.5	Negligible
R12	17.6	18	0.4	Negligible	18	0.4	Negligible
R13	18.1	18.2	0.1	Negligible	-	-	-
R14	18.4	18.7	0.3	Negligible	-	-	-
R15	17.7	18	0.3	Negligible	18	0.3	Negligible
R16	17.6	19.2	1.6	Negligible	18.9	1.3	Negligible

Receptor	Do-Minimum ($\mu g/m^3$)	Without noise barriers)			With noise barriers		
		Do-Something ($\mu g/m^3$)	Change in PM_{10} ($\mu g/m^3$)	Impact	Do-Something ($\mu g/m^3$)	Change in PM_{10} ($\mu g/m^3$)	Impact
R17	17.7	18.9	1.2	Negligible	18.6	0.9	Negligible
R18	17.7	17.9	0.2	Negligible	-	-	-
R19	17.6	17.8	0.2	Negligible	-	-	-
R20	17.6	18.2	0.6	Negligible	18.2	0.6	Negligible
R21	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R22	17.6	18.2	0.6	Negligible	18.1	0.5	Negligible
R23	17.6	17.9	0.3	Negligible	17.9	0.3	Negligible
R24	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R25	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R26	17.7	17.7	0	Negligible	-	-	-
R27	18.2	18.2	0	Negligible	-	-	-
R28	17.8	17.9	0.1	Negligible	-	-	-

Predicted annual mean concentrations are all well below the limit value (40μg/m^3) at all locations in 2024 and 2039. The maximum concentration was predicted at R16 (19.2μg/m^3 in 2039), where the maximum change in concentration (1.6μg/m^3) was predicted. These levels were reduced following the inclusion of noise barriers. A negligible impact was predicted at all locations, refer to **Tables 16.4**, **16.5** and **16.6**.

The WHO guideline level is complied with at all receptor points.

$PM_{2.5}$

Annual mean $PM_{2.5}$ concentrations were predicted at the assessed receptor locations for the future year when the proposed road development opens (2024) and the Design Year (2039).

Predicted annual mean $PM_{2.5}$ concentrations for the Do-Minimum and Do-Something scenarios, the change in concentrations as a result of the proposed road development and the impact descriptor at each receptor are shown in **Table 16.33** and **Table 16.34**, for the Opening Year (2024) and Design Year (2039), respectively. Results of modelling with the noise barriers in place area also included for the receptors, where relevant.

Table 16.33: Predicted concentrations of $PM_{2.5}$ ($\mu g/m^3$), 2024

Receptor	Do-Minimum ($\mu g/m^3$)	Without noise barriers)			With noise barriers		
		Do-Something ($\mu g/m^3$)	Change in $PM_{2.5}$ ($\mu g/m^3$)	Impact	Do-Something ($\mu g/m^3$)	Change in $PM_{2.5}$ ($\mu g/m^3$)	Impact
R01	8.2	8.3	0.1	Negligible	-	-	-
R02	8.7	8.8	0.1	Negligible	-	-	-
R03	8.4	8.5	0.1	Negligible	-	-	-
R04	8.3	8.4	0.1	Negligible	8.4	0.1	Negligible
R05	8.1	8.1	0	Negligible	-	-	-
R06	8.5	8.8	0.3	Negligible	8.8	0.3	Negligible
R07	8.5	8.5	0	Negligible	-	-	-
R08	8.4	8.5	0.1	Negligible	-	-	-
R09	8.2	8.3	0.1	Negligible	-	-	-
R10	8.1	8.3	0.2	Negligible	-	-	-
R11	8.1	8.4	0.3	Negligible	8.4	0.3	Negligible
R12	8.1	8.3	0.2	Negligible	8.3	0.2	Negligible
R13	8.4	8.4	0	Negligible	-	-	-
R14	8.6	8.6	0	Negligible	-	-	-
R15	8.1	8.4	0.3	Negligible	8.4	0.3	Negligible
R16	8.1	9	0.9	Negligible	8.8	0.7	Negligible
R17	8.1	8.7	0.6	Negligible	8.6	0.5	Negligible
R18	8.1	8.2	0.1	Negligible	-	-	-
R19	8.1	8.2	0.1	Negligible	-	-	-
R20	8.1	8.4	0.3	Negligible	8.4	0.3	Negligible
R21	8.1	8.2	0.1	Negligible	8.2	0.1	Negligible
R22	8.1	8.4	0.3	Negligible	8.3	0.2	Negligible
R23	8.1	8.2	0.1	Negligible	8.2	0.1	Negligible
R24	8.1	8.2	0.1	Negligible	8.2	0.1	Negligible
R25	8.1	8.2	0.1	Negligible	8.2	0.1	Negligible
R26	8.1	8.1	0	Negligible	-	-	-
R27	8.4	8.4	0	Negligible	-	-	-
R28	8.2	8.2	0	Negligible	-	-	-

Table 16.34: Predicted concentrations of $PM_{2.5}$ (µg/m³), 2039

Receptor	Do-Minimum (µg/m³)	Without noise barriers			With noise barriers		
		Do-Something (µg/m³)	Change in $PM_{2.5}$ (µg/m³)	Impact	Do-Something (µg/m³)	Change in $PM_{2.5}$ (µg/m³)	Impact
R01	10.1	10.3	0.2	Negligible	-	-	-
R02	10.6	10.7	0.1	Negligible	-	-	-
R03	10.3	10.5	0.2	Negligible	-	-	-
R04	10.2	10.3	0.1	Negligible	10.3	0.1	Negligible
R05	10	10	0	Negligible	-	-	-
R06	10.4	10.6	0.2	Negligible	10.6	0.2	Negligible
R07	10.4	10.5	0.1	Negligible	-	-	-
R08	10.3	10.4	0.1	Negligible	-	-	-
R09	10.2	10.2	0	Negligible	-	-	-
R10	10	10.2	0.2	Negligible	-	-	-
R11	10	10.4	0.4	Negligible	10.3	0.3	Negligible
R12	10	10.3	0.3	Negligible	10.3	0.3	Negligible
R13	10.3	10.3	0	Negligible	-	-	-
R14	10.5	10.7	0.2	Negligible	-	-	-
R15	10	10.3	0.3	Negligible	10.3	0.3	Negligible
R16	10	11	1	Negligible	10.8	0.8	Negligible
R17	10	10.8	0.8	Negligible	10.6	0.6	Negligible
R18	10	10.2	0.2	Negligible	-	-	-
R19	10	10.1	0.1	Negligible	-	-	-
R20	10	10.4	0.4	Negligible	10.3	0.3	Negligible
R21	10	10.1	0.1	Negligible	10.1	0.1	Negligible
R22	10	10.3	0.3	Negligible	10.3	0.3	Negligible
R23	10	10.1	0.1	Negligible	10.1	0.1	Negligible
R24	10	10.1	0.1	Negligible	10.1	0.1	Negligible
R25	10	10.1	0.1	Negligible	10.1	0.1	Negligible
R26	10.1	10.1	0	Negligible	-	-	-
R27	10.4	10.4	0	Negligible	-	-	-
R28	10.1	10.2	0.1	Negligible	-	-	-

Predicted annual mean concentrations are all well below the limit value (20µg/m³) at all locations in 2024 and 2039. The maximum concentration was predicted at R16 (9µg/m³ in 2024), where the maximum change in concentration (0.9µg/m³) was predicted. A negligible impact was predicted at all locations, refer to **Tables 16.4**, **16.5** and **16.6**.

The WHO guideline level is exceeded at all receptor points, excluding R05 and R26 in 2024 and R05 in 2039. The exceedances are due to the contribution of background concentrations.

NOx

The proposed road development crosses the Lough Corrib cSAC. The concentration of NOx along four transects 200m from where the proposed road development crosses the Lough Corrib cSAC have been predicted. The background NOx concentration listed in **Table 16.19** (11.2µg/m^3) has been added to the modelled results. Noise barriers are located alongside part of this section of the route and the results of modelling with the noise barriers in place have therefore also been included. The results and the change in concentrations for 2024 and 2039 are listed in **Table 16.35** and **Table 16.36** respectively for each of the four transects described in **Section 16.2.5.1**.

Table 16.35: Predicted NO_x concentrations (µg/m^3) at Lough Corrib cSAC, 2024

Distance from proposed road (m)	Do-Minimum (µg/m^3)	Without noise barriers			With noise barriers		
		Do-Something (µg/m^3)	Change in NO_x (µg/m^3)	Impact	Do-Something (µg/m^3)	Change in NO_x (µg/m^3)	Impact
Transect 1							
10	11.6	16.9	5.3	Slight adverse	16.9	5.3	Slight adverse
20	11.6	15.7	4.1	Slight adverse	15.7	4.1	Slight adverse
30	11.6	15	3.4	Slight adverse	15	3.4	Slight adverse
40	11.6	14.6	3	Slight adverse	14.6	3	Negligible
50	11.6	14.2	2.6	Negligible	14.2	2.6	Negligible
60	11.6	14	2.4	Negligible	14	2.4	Negligible
70	11.6	13.8	2.2	Negligible	13.8	2.2	Negligible
80	11.6	13.7	2.1	Negligible	13.7	2.1	Negligible
90	11.6	13.6	2	Negligible	13.6	2	Negligible
100	11.6	13.5	1.9	Negligible	13.5	1.9	Negligible
110	11.6	13.4	1.8	Negligible	13.4	1.8	Negligible
120	11.6	13.3	1.7	Negligible	13.3	1.7	Negligible
130	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible
140	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible
150	11.6	13.1	1.5	Negligible	13.1	1.5	Negligible
160	11.6	13.1	1.5	Negligible	13.1	1.5	Negligible
170	11.6	13	1.4	Negligible	13	1.4	Negligible
180	11.6	13	1.4	Negligible	13	1.4	Negligible
190	11.6	13	1.4	Negligible	13	1.4	Negligible

Distance from proposed road (m)	Do-Minimum (μg/m³)	Without noise barriers			With noise barriers		
		Do-Something (μg/m³)	Change in NO_x (μg/m³)	Impact	Do-Something (μg/m³)	Change in NO_x (μg/m³)	Impact
200	11.6	12.9	1.3	Negligible	12.9	1.3	Negligible
Transect 2							
10	11.5	18.4	6.9	Slight adverse	18.4	6.9	Slight adverse
20	11.5	16.7	5.2	Slight adverse	16.7	5.2	Slight adverse
30	11.5	15.8	4.3	Slight adverse	15.8	4.3	Slight adverse
40	11.5	15.3	3.8	Slight adverse	15.3	3.8	Negligible
50	11.5	14.9	3.4	Negligible	14.9	3.4	Negligible
60	11.5	14.6	3.1	Negligible	14.6	3.1	Negligible
70	11.5	14.4	2.9	Negligible	14.4	2.9	Negligible
80	11.5	14.2	2.7	Negligible	14.3	2.8	Negligible
90	11.5	14.1	2.6	Negligible	14.1	2.6	Negligible
100	11.5	14	2.5	Negligible	14	2.5	Negligible
110	11.5	13.9	2.4	Negligible	13.9	2.4	Negligible
120	11.5	13.8	2.3	Negligible	13.8	2.3	Negligible
130	11.5	13.7	2.2	Negligible	13.7	2.2	Negligible
140	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
150	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
160	11.5	13.5	2	Negligible	13.5	2	Negligible
170	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
180	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
190	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
200	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
Transect 3							
10	11.5	17.4	5.9	Slight adverse	17.4	5.9	Slight adverse
20	11.5	16.1	4.6	Slight adverse	16.1	4.6	Slight adverse
30	11.5	15.3	3.8	Slight adverse	15.3	3.8	Slight adverse
40	11.5	14.8	3.3	Slight adverse	14.8	3.3	Negligible
50	11.5	14.5	3	Negligible	14.5	3	Negligible
60	11.5	14.2	2.7	Negligible	14.2	2.7	Negligible
70	11.5	14	2.5	Negligible	14	2.5	Negligible

Distance from proposed road (m)	Do-Minimum (µg/m^3)	Without noise barriers			With noise barriers		
		Do-Something (µg/m^3)	Change in NO_x (µg/m^3)	Impact	Do-Something (µg/m^3)	Change in NO_x (µg/m^3)	Impact
80	11.5	13.8	2.3	Negligible	13.8	2.3	Negligible
90	11.5	13.7	2.2	Negligible	13.7	2.2	Negligible
100	11.5	13.5	2	Negligible	13.5	2	Negligible
110	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
120	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
130	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
140	11.5	13.2	1.7	Negligible	13.2	1.7	Negligible
150	11.5	13.2	1.7	Negligible	13.2	1.7	Negligible
160	11.5	13.1	1.6	Negligible	13.1	1.6	Negligible
170	11.5	13.1	1.6	Negligible	13.1	1.6	Negligible
180	11.5	13	1.5	Negligible	13	1.5	Negligible
190	11.5	13	1.5	Negligible	13	1.5	Negligible
200	11.5	12.9	1.4	Negligible	12.9	1.4	Negligible
Transect 4							
10	11.5	21.2	9.7	Slight adverse	18.4	6.9	Slight adverse
20	11.5	18.2	6.7	Slight adverse	16.9	5.4	Slight adverse
30	11.5	16.8	5.3	Slight adverse	16	4.5	Slight adverse
40	11.5	15.8	4.3	Slight adverse	15.3	3.8	Negligible
50	11.5	15.2	3.7	Negligible	14.9	3.4	Negligible
60	11.5	14.8	3.3	Negligible	14.5	3	Negligible
70	11.5	14.5	3	Negligible	14.3	2.8	Negligible
80	11.5	14.2	2.7	Negligible	14	2.5	Negligible
90	11.5	14	2.5	Negligible	13.8	2.3	Negligible
100	11.5	13.8	2.3	Negligible	13.7	2.2	Negligible
110	11.5	13.6	2.1	Negligible	13.5	2	Negligible
120	11.5	13.5	2	Negligible	13.4	1.9	Negligible
130	11.5	13.4	1.9	Negligible	13.3	1.8	Negligible
140	11.5	13.3	1.8	Negligible	13.2	1.7	Negligible
150	11.5	13.2	1.7	Negligible	13.1	1.6	Negligible
160	11.5	13.1	1.6	Negligible	13	1.5	Negligible
170	11.5	13	1.5	Negligible	13	1.5	Negligible
180	11.5	13	1.5	Negligible	12.9	1.4	Negligible

Distance from proposed road (m)	Do-Minimum (μg/m^3)	Without noise barriers			With noise barriers		
		Do-Something (μg/m^3)	Change in NO_x (μg/m^3)	Impact	Do-Something (μg/m^3)	Change in NO_x (μg/m^3)	Impact
190	11.5	12.9	1.4	Negligible	12.9	1.4	Negligible
200	11.5	12.9	1.4	Negligible	12.9	1.4	Negligible

Table 16.36: Predicted NOx concentrations (μg/m^3) at Lough Corrib SAC, 2039

Distance from propose d road (m)	Do-Minimum (μg/m^3)	Without noise barriers			With noise barriers		
		Do-Something (μg/m^3)	Change in NO_x (μg/m^3)	Impact	Do-Something (μg/m^3)	Change in NO_x (μg/m^3)	Impact
Transect 1							
10	11.6	17.9	6.3	Slight adverse	17.9	6.3	Slight adverse
20	11.6	16.4	4.8	Slight adverse	16.4	4.8	Slight adverse
30	11.6	15.6	4	Slight adverse	15.6	4	Slight adverse
40	11.6	15.1	3.5	Slight adverse	15.1	3.5	Slight adverse
50	11.6	14.7	3.1	Slight adverse	14.7	3.1	Slight adverse
60	11.6	14.4	2.8	Negligible	14.4	2.8	Negligible
70	11.6	14.2	2.6	Negligible	14.2	2.6	Negligible
80	11.6	14	2.4	Negligible	14	2.4	Negligible
90	11.6	13.9	2.3	Negligible	13.9	2.3	Negligible
100	11.6	13.7	2.1	Negligible	13.7	2.1	Negligible
110	11.6	13.6	2	Negligible	13.6	2	Negligible
120	11.6	13.5	1.9	Negligible	13.5	1.9	Negligible
130	11.6	13.5	1.9	Negligible	13.5	1.9	Negligible
140	11.6	13.4	1.8	Negligible	13.4	1.8	Negligible
150	11.6	13.3	1.7	Negligible	13.3	1.7	Negligible
160	11.6	13.3	1.7	Negligible	13.3	1.7	Negligible
170	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible
180	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible
190	11.6	13.1	1.5	Negligible	13.1	1.5	Negligible
200	11.6	13.1	1.5	Negligible	13.1	1.5	Negligible
Transect 2							
10	11.5	19.4	7.9	Slight adverse	19.4	7.9	Slight adverse

Distance from propose d road (m)	Do-Minimum (µg/m³)	Without noise barriers			With noise barriers		
		Do-Something (µg/m³)	Change in NO_x (µg/m³)	Impact	Do-Something (µg/m³)	Change in NO_x (µg/m³)	Impact
20	11.5	17.4	5.9	Slight adverse	17.4	5.9	Slight adverse
30	11.5	16.3	4.8	Slight adverse	16.3	4.8	Slight adverse
40	11.5	15.6	4.1	Slight adverse	15.6	4.1	Slight adverse
50	11.5	15.2	3.7	Slight adverse	15.2	3.7	Slight adverse
60	11.5	14.8	3.3	Negligible	14.8	3.3	Negligible
70	11.5	14.6	3.1	Negligible	14.6	3.1	Negligible
80	11.5	14.4	2.9	Negligible	14.4	2.9	Negligible
90	11.5	14.2	2.7	Negligible	14.2	2.7	Negligible
100	11.5	14	2.5	Negligible	14	2.5	Negligible
110	11.5	13.9	2.4	Negligible	13.9	2.4	Negligible
120	11.5	13.8	2.3	Negligible	13.8	2.3	Negligible
130	11.5	13.7	2.2	Negligible	13.7	2.2	Negligible
140	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
150	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
160	11.5	13.5	2	Negligible	13.5	2	Negligible
170	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
180	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
190	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
200	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
Transect 3							
10	11.5	18.5	7	Slight adverse	18.5	7	Slight adverse
20	11.5	16.9	5.4	Slight adverse	16.9	5.4	Slight adverse
30	11.5	16	4.5	Slight adverse	16	4.5	Slight adverse
40	11.5	15.4	3.9	Slight adverse	15.4	3.9	Slight adverse
50	11.5	15	3.5	Slight adverse	15	3.5	Slight adverse
60	11.5	14.6	3.1	Negligible	14.6	3.1	Negligible
70	11.5	14.4	2.9	Negligible	14.4	2.9	Negligible
80	11.5	14.2	2.7	Negligible	14.2	2.7	Negligible
90	11.5	14	2.5	Negligible	14	2.5	Negligible

Distance from proposed road (m)	Do-Minimum (μg/m^3)	Without noise barriers			With noise barriers		
		Do-Something (μg/m^3)	Change in NO_x (μg/m^3)	Impact	Do-Something (μg/m^3)	Change in NO_x (μg/m^3)	Impact
100	11.5	13.9	2.4	Negligible	13.9	2.4	Negligible
110	11.5	13.7	2.2	Negligible	13.7	2.2	Negligible
120	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
130	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
140	11.5	13.5	2	Negligible	13.5	2	Negligible
150	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
160	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
170	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
180	11.5	13.2	1.7	Negligible	13.2	1.7	Negligible
190	11.5	13.2	1.7	Negligible	13.2	1.7	Negligible
200	11.5	13.1	1.6	Negligible	13.1	1.6	Negligible
Transect 4							
10	11.6	23.2	11.6	Slight adverse	19.8	8.2	Slight adverse
20	11.6	19.7	8.1	Slight adverse	18	6.4	Slight adverse
30	11.6	17.9	6.3	Slight adverse	16.9	5.3	Slight adverse
40	11.6	16.7	5.1	Slight adverse	16.1	4.5	Slight adverse
50	11.6	16	4.4	Slight adverse	15.6	4	Slight adverse
60	11.6	15.5	3.9	Negligible	15.1	3.5	Negligible
70	11.6	15.1	3.5	Negligible	14.9	3.3	Negligible
80	11.6	14.8	3.2	Negligible	14.6	3	Negligible
90	11.6	14.5	2.9	Negligible	14.4	2.8	Negligible
100	11.6	14.3	2.7	Negligible	14.2	2.6	Negligible
110	11.6	14.1	2.5	Negligible	14	2.4	Negligible
120	11.6	13.9	2.3	Negligible	13.8	2.2	Negligible
130	11.6	13.8	2.2	Negligible	13.7	2.1	Negligible
140	11.6	13.7	2.1	Negligible	13.6	2	Negligible
150	11.6	13.5	1.9	Negligible	13.5	1.9	Negligible
160	11.6	13.4	1.8	Negligible	13.4	1.8	Negligible
170	11.6	13.4	1.8	Negligible	13.3	1.7	Negligible
180	11.6	13.3	1.7	Negligible	13.3	1.7	Negligible
190	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible

Distance from propose d road (m)	Do-Minimum ($\mu g/m^3$)	Without noise barriers			With noise barriers		
		Do-Something ($\mu g/m^3$)	Change in NO_x ($\mu g/m^3$)	Impact	Do-Something ($\mu g/m^3$)	Change in NO_x ($\mu g/m^3$)	Impact
200	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible

Predicted annual mean NO_x concentrations are all below the limit value (30µg/m^3). A maximum concentration of 23.2µg/m^3 was predicted at 10m from the proposed road development in 2039 (transect 4). A lower concentration of 19.8µg/m^3 was predicted with the noise barrier in place. In 2039, without the noise barriers in place, a slight adverse impact was predicted at distances from 10m to 50m with a negligible impact at further distances. With the noise barriers in place, the impact rating remains the same.

16.5.4.3 Regional air quality impacts

The DMRB regional approach was used to estimate total emissions from the existing road network. The assessment focuses on the change in emissions of nitrogen oxides, total hydrocarbons (THC) and particulate matter in the Opening and Design Years. **Table 16.37** presents the predicted pollutant emissions at regional level.

Table 16.37: Predicted NO_x, THC and PM_{10} Emissions at Regional Level for 2024 and 2039 (Tonnes per Annum)

	Scenario	NOx (t/a)	THC (t/a)	PM_{10} (t/a)
2024	DM	135	32	5.6
	DS	186	40	7.8
	DS - DM	51	8	2.2
2039	DM	171	38	7.0
	DS	242	50	9.9
	DS - DM	72	12	2.9
	% of change (2039) relative to Directive Limits	0.11%	0.02%*	n/a

*Note: * limit for VOC*

Nitrogen oxides are predicted to increase by 0.1% of the Directive 2016/2284 limit for NO_x in 2039. THC are predicted to increase by 0.02% of the Directive limit for VOC in 2030, refer to **Section 16.2.2.1**.

As there is no national reporting of particulate matter levels and no Directive limits exist, no comparison of annual particulate matter emissions can be made.

16.5.4.4 Potential Construction Impacts on Climate

Based on expected construction activities and methods, CO_2 values have been estimated during the construction phase, refer to **Table 16.38**.

Table 16.38: Total Estimated CO_2 Produced as a result of the Construction of the Proposed Road Development

	tonnes/year
Ireland's non-ETS CO_2 Commitment for 2020	38,000,000
Total CO_2 during construction phase Year 1 (maximum emissions)	150,000
Increase relative to CO_2 commitment per year	0.39%
Total CO_2 during construction phase	275,000

During the construction phase of the proposed road development, 150,000 tonnes per year of CO_2 are estimated to be generated, assuming a 36-month construction programme. Ireland has committed to achieve a 20% reduction in non-ETS greenhouse gas emissions by 2020 (relative to 2005 levels). The emissions predicted to be produced during the construction phase of the proposed road development constitutes 0.39% of Ireland's 2020 CO_2 limit under the EU Climate Change and Renewable Energy Package. These emissions will occur for the duration of the construction phase. Measures to mitigate these potential impacts are outlined in **Section 16.6**.

16.5.4.5 Potential Operational Impacts on Climate

Macro Climate

Table 16.39 describes the predicted CO_2 produced as a result of the proposed road development. The results include CO_2 levels based on Do-Minimum and Do-Something for both 2024 and 2039. Results are based on traffic data for the proposed road development and include the design speed for each existing and proposed road, refer to **Chapter 6, Traffic Assessment and Route Cross-section**. Ireland has committed to achieve a 20% reduction in non-ETS greenhouse gas emissions by 2020 (relative to 2005 levels). Predicted changes in levels of CO_2 due to the proposed road development are compared to Ireland's non-ETS commitments under the EU Climate Change and Renewable Energy Package. The projected increase of CO_2 in 2039 is 0.094% of Ireland's non-ETS commitment.

Table 16.39: Total Estimated CO_2 Produced as a result of the Operation of the Proposed Road Development

Scenario	**Tonnes/year**
Ireland's non-ETS CO_2 Commitment for 2020	38,000,000
Total CO_2 as a result of scheme 2024 (DM-DS) [1]	26,059
Change relative to CO_2 commitment	0.069%
Total CO_2 as a result of scheme 2039 (DM-DS) [1]	35,776
Change relative to CO_2 commitment	0.094%

Note:[1] Total C converted to total CO_2 using a factor of 44/12

It should be noted that the calculations include for a worst-case scenario which considers traffic within the city centre travelling at speed limits. In reality, these speeds are likely to be significantly slower particularly during peak times.

In order to replicate the existing congestion in Galway City, an assessment of the Do-Minimum scenarios for both 2024 and 2039 were undertaken using slower speeds than the design speeds for city centre link roads.

Traffic speeds were reduced by 50% and 75% for internal City link roads for the Do-Minimum scenarios in order to determine the potential change in CO_2 emissions.

- For a 50% reduction in traffic speeds for the Do-Minimum scenario, CO_2 emissions (DS-DM) for 2024 decrease from 26,059 tonnes per year to 17,233 tonnes per year; a 34% decrease compared to emissions at the speed limits. For 2039, CO_2 emissions for 2039 decrease from 35,776 tonnes per year to 26,129 tonnes per year; a 27% decrease compared to emissions at speed limits
- For a 75% reduction in traffic speeds for the Do-Minimum scenario, CO_2 emissions (DS-DM) for 2024 decrease from 26,059 tonnes per year to 8,686 tonnes per year; a 67% decrease compared to emissions at speed limits. For 2039, CO_2 emissions for 2039 decrease from 35,776 tonnes per year to 16,672 tonnes per year; a 53% decrease compared to emissions at speed limits
- When a congested (75% of design speed) Do-Minimum scenario is assessed against the Do-Something scenario, this predicted to result in a change of 0.023% of the EU Ireland's non-ETS CO2 Commitment for 2020 and 0.044% in 2039

Micro-Climate

The proposed road development will result in changes to the shape of the existing terrain. Such changes may modify airflow and temperature profiles in the area. These modifications will not be significant from a climatic perspective and are unlikely to result in any adverse impact on local flora and fauna and residential populations.

16.6 Mitigation Measures

16.6.1 Introduction

A description of the proposed air quality and climate mitigation measures to be implemented during the construction and operational phases are described below.

16.6.2 Construction Phase

16.6.2.1 Air quality

Emissions to air during earthmoving and construction will occur, although the prevailing weather, the size of the site and its distance from sensitive receptors will assist in facilitating the management of any effects. The focus of the control procedures will therefore be to reduce the generation of airborne material.

The assessment of potential construction impacts contained in **Section 16.5.3** includes the implementation of 'standard mitigation', as stated in the TII Guidelines. This shall include the following measures:

- Spraying of exposed earthwork activities and site haul roads during dry weather
- Provision of wheel washes at exit points
- Control of vehicle speeds and speed restrictions. It is proposed that site traffic is restricted to 20km/hr. This will help to minimise the occurrence of dust re-suspension
- Sweeping of hard surface roads

In addition, the following measures will be implemented. These measures are based on best practice as outlined in the British Research Establishment (BRE) document 'Controlling particles, vapour and noise pollution from construction sites' and the Institute of Air Quality Management (IAQM) 'Guidance on the assessment of dust from demolition and construction', 2016.

- A public communication strategy will be implemented by the Contractor which will outline procedures to inform members of the community on activities that may be disruptive, further details are contained in **Appendix A.7.5 Construction Environmental Management Plan**. This appendix also includes details of a complaints register which will be implemented during the construction phase
- Exhaust emissions from vehicles operating within the site, including trucks, excavators, diesel generators or other plant equipment, will be controlled by the contractor through regular servicing of machinery
- During dry periods when dust generation is likely or during windy periods, construction areas and vehicles delivering material with dust forming potential will also be sprayed with water, as appropriate
- Areas where materials will be handled and stockpiled will be positioned away from main site access roads. These areas will also be designed to minimise their exposure to wind – all stockpiles shall be kept to the minimum practicable height with gentle slopes
- There shall be no long-term stockpiling on site and storage time will be minimised
- Material drop heights from plant to plant or from plant to stockpile will be minimised
- Water suppression will be used during the demolition of buildings
- Crushing and concrete batching plant will be located as far from sensitive receptors as is reasonably practicable. All storage bins and transfer points will be covered. Silos will be fitted with reverse jet air filters

Dust screens will be implemented at locations where there is the potential for air quality impacts during the construction phase as outlined in **Section 16.5.3**, i.e. at locations where sensitive receptors are located within 100m of the works. In addition, a 2m dust screen will be provided at the locations at the locations in the areas of the overlap of the proposed road development and the Lough Corrib cSAC and the area of the proposed road development adjacent to Moycullen Bogs NHA.

Employee awareness is also a most important way that dust may be controlled on any site. Staff training and the vigilant management of operations ensure that all dust suppression methods are implemented and continuously inspected. Further details on employee training are provided in the Construction Environmental Management Plan (CEMP) in **Appendix A.7.5**.

Dust deposition monitoring will be conducted at a number of locations in the vicinity of the proposed road development. At a minimum, monitoring will be carried out at the two nearest sensitive receptors at locations where works of a ‘major’ scale is proposed while works are taking place in proximity, refer to **Section 16.5.3.1**. Monitoring will be carried out using the Bergerhoff method, i.e. analysis of dust collecting jars left on-site (German Standard VDI 2119, 1972). Results will be compared to the TA Luft guidelines. Should an exceedance of the TA Luft limit occur during the construction phase or a complaint be received in relation to dust levels, additional mitigation measures, for example more regular spraying of water, will be implemented. At least one month of dust deposition monitoring will be carried out in advance of the commencement of works to determine a baseline.

In addition, it is proposed to carry out particulate monitoring (PM_{10} and $PM_{2.5}$) at the nearest sensitive receptors upwind and downwind of the construction works where sensitive receptors have been identified within 25m of the works, refer to **Section 16.5.3.1**. This monitoring programme will take place when works likely to generate dust are being carried out. The monitoring will allow direct comparison with the PM_{10} and $PM_{2.5}$ air quality standards on a daily basis.

The particulate and dust deposition limits will be used to determine potential occurrences of dust nuisance associated with the proposed construction works. Should the limit values be approaching an exceedance during the construction works, the levels will be recorded by the contractor. An investigation will subsequently be carried out to determine potential causes and the options available to reduce the level of dust.

All potential causes for the high levels will be analysed. These will include the construction works taking place, potential off site sources and meteorological conditions. Should the construction works taking place be identified as the primary cause of the high level, the contractor will ensure that the mitigation measures listed above are improved upon. Should high dust levels continue to occur following these improvements, the contractor will provide alternative mitigation measures and/or will modify the construction works taking place.

16.6.2.2 Climate

The following mitigation measures will be implemented during the construction phase of the development so as to minimise CO_2 emissions:

- Materials required for the construction works will be sourced locally where possible. There are operational quarries located in proximity to the proposed road development. Rock crushing will be undertaken on site where possible, to reduce the requirement to import crushed stone to site
- The Construction Traffic Management Plan outlined in the CEMP in **Appendix A.7.5** will be implemented in full. This will minimise congestion and encourage car sharing and the use of public transport
- Materials will be handled efficiently on site to minimise the waiting time for loading and unloading, thereby reducing potential emissions
- Engines will be turned off when machinery is not in use
- The regular maintenance of plant and equipment will be carried out
- Materials with a reduced environmental impact will be used where available, such as:
    - Ground Granulated Blast Furnace Slag (GGBS) and Pulverished Fly Ash (PFA) will be used as replacements for Portland cements
    - Recycled steel

The Contractor will be required to implement an Energy Management System for the duration of the works. This will include the following at a minimum:

- Use of thermostatic controls on all heating systems in site buildings
- The use of insulated temporary building structures
- The use of low energy equipment and power saving functions on all computer systems
- The use of low flow tap fittings and showers

The use of solar/thermal power to heat water for the on-site welfare facilities including sinks and showers.

16.6.3 Operational Phase

16.6.3.1 Air Quality

As it is predicted that all air quality standards for the protection of human health and vegetation will be complied with, no specific mitigation measures are required.

At a National / European level, improvements in air quality are likely over the next few years as a result of the on-going comprehensive vehicle inspection and maintenance program, fiscal measures to encourage the use of alternatively fuelled vehicles and the introduction of cleaner fuels.

16.6.3.2 Climate

The *Transport Infrastructure Ireland Environmental Impact Assessment of National Road Schemes – A Practical Guide* notes that climate change issues are largely outside the scope of an EIAR for individual road schemes as the issues and mitigation measures are the subject of specific policies and strategies set out by government.

However, it is anticipated that the proposed road development will assist with the removal of traffic congestion from within Galway City and its environs by transferring existing and future traffic from the existing road network to the new road infrastructure. Therefore, journey times will reduce and journey time certainty will increase for both public transport and private vehicle users. The reduction in traffic congestion will reallocate the space for cyclists, pedestrians and reconfigure the public transport network. This will result in reducing the number of short commuter journeys by car by facilitating journeys by bicycle/on foot. The positive impact of this modal shift is difficult to quantify in terms of carbon emissions however, it will help to reduce emissions.

Improvements to the Galway bus network have been identified as necessary to better cater for existing and future travel patterns in Galway City. The reallocation of road space for public transport will assist with the delivery of an improved bus network resulting in carbon emission reductions.

In addition, the provision of improved public transport, traffic management measures, cycling and walking facilities and the introduction of the ‘Cross-city Link’ by the GTS will encourage a modal shift in line with Smarter Travel - A Sustainable Transport Future, A New Transport Policy for Ireland 2009 – 2020. This shift has the potential to reduce greenhouse gas emissions associated with the proposed road development in the future.

CO_2 emissions for the average new car fleet were reduced to 120g/km by 2012 through EU legislation on improvements in vehicle motor technology and by an increased use of biofuels.

The National Mitigation Plan outlines a number of existing mitigation measures and future possible mitigation measures under consideration relating to road transport, as follows:

Existing:

- Taxation system where a lesser road tax is paid where CO_2 emissions are within lower bands
- Grants provided by Sustainable Energy Authority Ireland (SEAI) to incentivise the purchase of electric vehicles
- Deploy natural gas refuelling stations and gas injection facilities
- Using intelligent transport systems (ITS) to enhance the efficiency of infrastructure and fuel use in a transport network

Under consideration:

- Further measures to accelerate the take-up of low carbon technologies
- Increase in carbon tax on transport fuel
- The motor tax and VRT system could be further amended in line with improvements to energy efficiency and emissions reductions in cars and vans

to additionally incentivise or maintain the advantages of purchasing of the lowest emitting vehicles

- encourage the take-up of alternatively fuelled vehicles, removing or reducing supports or preferential treatment for petrol and diesel fuelled vehicles
- Reduce maximum speed limits on motorways to 110km/hr in order to reduce emissions. It is noted that the design speed for the proposed road development at 100km/hr is less than the 120km/hr that usually applies to motorway schemes

16.7 Residual Impacts

16.7.1 Introduction

Residual impacts are assessed for the construction and operational phases of the proposed road development.

16.7.2 Construction Phase

The residual impact on air quality as a result of the proposed road development will not be significant following the implementation of mitigation measures outlined above. Dust deposition and PM_{10}/$PM_{2.5}$ monitoring shall be carried out to confirm the effectiveness of the mitigation measures.

16.7.3 Operational Phase

As it is predicted that all air quality standards for the protection of human health and vegetation will be complied with, no residual impacts are envisaged. See **Chapter 18, Human Beings, Population and Human Health** for an appraisal of potential health impacts.

It is expected that potential carbon emissions generated by the proposed road development can be offset by measures outlined in the Galway Transport Strategy, removing congestion in Galway City and measures outlined in the National Mitigation Plan.

16.7.4 Cumulative Impacts

The traffic data used in the assessment for future years, considers development proposed for the Galway area listed below, and incorporates the cumulative impacts of these projects into the 'Do-Minimum' traffic data used in this EIAR.

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)

- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Transport Strategy (GTS), which includes the following:
  - Investigation of prospective sites to the east of the city for Park and Ride
  - Bearna Greenway
  - Galway to Oughterard (part of the Galway to Clifden) Greenway
  - Galway City to Oranmore (part of the Galway to Dublin) Cycleway

No major construction works are envisaged to take place in such proximity to the proposed road development which would significantly impact on dust levels.

The cumulative impacts are considered by incorporating background concentrations into predicted values and existing traffic volumes and are described in the impact assessment sections above.

The main aim of the Galway Transport Strategy is to address the current and future transport requirements of Galway City and its environs.

This includes the provision of new transport infrastructure, as follows:

- Public transport: the introduction of a 'Cross City Link' to increase the amount of people able to access the heart of the city by public transport
- Walking and cycling: ensuring that a network of cycle and walking routes is developed across the city and its environs
- Road network: Providing improved access and movement across and within Galway City and its environs

The proposed road development has been assessed with reference to the objectives of the Galway Transport Strategy. Negative significant cumulative impacts on air quality will not arise.

16.8 Summary

The potential air quality and climate impact of the proposed road development has been assessed during the construction and operational phases. During the operational phase, all air quality standards are predicted to be complied with and a worst-case impact of slight adverse is expected. Following the implementation of mitigation measures, no significant residual air quality and climate impacts are envisaged. During the construction phase, particulate monitoring and dust deposition monitoring will be carried out to ensure the effectiveness of the mitigation measures and compliance with air quality standards.

16.9 References

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www.met.ie.

17 Noise and Vibration

17.1 Introduction

This chapter of the EIAR consists of an appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, under the heading of noise and vibration.

The chapter sets out the methodology (**Section 17.2**), describes the receiving environment (**Section 17.3**) and summarises the main characteristics of the proposed road development which are of relevance for noise and vibration (**Section 17.4**). The evaluation of impacts of the proposed road development on noise and vibration are described (**Section 17.5**). Measures are proposed to mitigate these impacts (**Section 17.6**) and residual impacts are described (**Section 17.7**). The chapter concludes with a summary (**Section 17.8**) and reference section (**Section 17.9**).

This chapter has utilised the information gathered during the constraints and route selection studies for the proposed road development to inform the noise and vibration impact appraisal. **Sections 4.15**, **6.5.10** and **7.6.10** of the **Route Selection Report** considered the noise and vibration constraints within the scheme study area and compared the potential noise and vibration impacts of the proposed route options respectively. These sections of the Route Selection Report contributed to the design of the proposed road development which this chapter appraises.

The key guidance documents referred to in this chapter are the TII 2004 *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* and the TII 2014 Document *Good Practice Guidelines for the Treatment of Noise during the Planning of National Road Schemes*, referred to as the TII 2004 Noise Guidelines and the TII 2014 Noise Guidelines respectively within this chapter.

17.2 Methodology

17.2.1 Introduction

In order to assess the noise impact of any proposed road development, the following methodology has been adopted:

- The first stage is to assess and quantify the existing noise environment in the vicinity of sensitive receptors that may be affected by the proposed road development. Noise sensitive receptors include residential properties, education buildings, hospitals and areas of high amenity value in existing low noise settings. In the case of a road scheme, the selected noise-sensitive locations are those in closest proximity to the proposed road development and along sections of existing roads where changes in traffic volumes are expected.
- The noise levels resulting from both the construction and operational phases for the future years are then calculated using established prediction techniques.

- The results of the predicted assessment are compared against the most appropriate criteria for both construction and operational phases. Where predicted noise levels are in excess of the adopted criteria, mitigation measures are proposed.

Further details of each phase of the assessment are set out in the individual sections of this chapter.

17.2.2 Relevant Guidelines

The assessment has been undertaken with reference to the most appropriate guidance documents relating to environmental noise and vibration from road traffic which are set out within the relevant sections of this chapter and included in the references section. Specifically, as noted in **Section 17.1**, the key guidance documents relating to this chapter are:

- TII 2004 Guidelines for the Treatment of Noise and Vibration in National Road Schemes
- TII 2014 Document Good Practice Guidelines for the Treatment of Noise during the Planning of National Road Schemes, (TII 2014)

In addition to specific noise guidance documents, the following guidelines were considered and consulted for the purposes of the proposed road development:

- Guidelines on the Information to be contained in Environmental Impact Statements', (EPA, 2002)
- 'EPA Advice Notes on Current Practice (in the preparation of Environmental Impact Statements), (EPA, 2003)
- 'EPA Advice Notes for Preparing Environmental Impact Statements, (Draft, September 2015)
- EPA Guidelines on the information to be contained in environmental impact assessment reports (Draft August 2017)

17.2.2.1 Construction Phase

Guidelines relating to construction noise and vibration limits are set out within the TII guidance documents and other relevant national and international documentation for the control of noise and vibration from construction sites. These are discussed in the following sections.

Construction Noise

The TII noise guidance documents specify noise levels that are deemed acceptable in terms of construction noise for new national roads. These limits are set out in **Table 17.1**.

Table 17.1: Maximum Permissible Noise Levels at the Facade of Dwellings during Construction Phase

Days and Times	Noise Levels (dB re. $2x10^{-5}$ Pa)	
	$L_{Aeq,1hr}$	L_{ASmax}
Monday to Friday 07:00 to 19:00hrs	70	80
Monday to Friday 19:00 to 22:00hrs	60*	65*
Saturdays 08:00 to 16:30hrs	65	75
Sundays & Bank Holidays 08:00 to 16:30hrs	60*	65*

Note * Construction activity at these times, other than that required for emergency works, will normally require the explicit permission of the local authority.

The TII guidelines do not include specific night-time construction noise limit values. In order to determine appropriate limits for any scheduled night-time works, best practice guidelines are taken from the British Standard BS5228 – 1: 2009 +A1 2014: *Code of practice for noise and vibration control on construction and open sites – Noise*. The standard provides guidance on setting appropriate limit values for construction based on exiting ambient noise levels in the absence of construction noise. The guidance levels for night-time periods are summarised in **Table.17.2**.

Table 17.2: Example Threshold of Significant Effect at Dwellings

Days and Times	Threshold Values (dB)		
	Category A [A]	Category B [B]	Category C [C]
Night-time 23:00 to 07:00hrs	45	50	55

- Note A: Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.
- Note B: Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.
- Note C: Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.

Construction Vibration

With regards to construction vibration, the TII guidelines outline the following limits in respect of ensuring that no cosmetic damage occurs to buildings in the vicinity of construction works.

Table 17.3: Allowable vibration during road construction in order to minimise the risk of building damage

Allowable vibration velocity (Peak Particle Velocity) at the closest part of any sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
8mm/s	12.5mm/s	20mm/s

Blasting

When assessing the potential impact of blasting, the relevant parameters used are both air overpressure and Peak Particle Velocity (PPV) mm/s. The TII guidelines recommends a PPV limit value of 12mm/s for blasting control. The Irish EPA Guidance *Environmental Management in the extraction industry* (2006) also recommend a PPV limit of 12mm/s in addition to an acceptable limit for air overpressure of 125dB (Lin) Peak Value. In addition, the EPA recommends blasting is only carried out between 09:00 – 18:00 Monday to Friday.

BS 6472 -2 2008: *Guide to Evaluation of Human Exposure to vibration in buildings. Part 2: Blast Induced Vibration* suggests satisfactory vibration magnitudes from blasting relating to human response. The document notes that for up to three blasts per day, a PPV limit value between 6 and 10mm/s is deemed reasonable, however it states these limit values relate to long term blasting operations from surface mineral extraction sites. The standard notes that *for civil engineering projects, such as tunnel and foundation excavations, it should be recognised that the application of human response criteria, rather than conservative damage criteria, could significantly prolong project durations. In turn this could lead to increased complaint levels.*

The standard notes higher levels may be more appropriate for short term projects, where good public relations, property surveys etc. are undertaken.

The frequency of blasting for the proposed road development will be no greater than one blast per day in any one site. Taking the blasting frequency into account, the nature of this engineering project and to expedite works as far as practical in excavation areas to avoid prolonged impacts, the limit values relating to structural damage are considered the most appropriate for this project, i.e. 12mm/s.

Disturbance of Particularly Vibration-Sensitive Equipment and Processes

There are no standard criteria for assessing the potential impact of vibration on sensitive equipment or processes. British Standard BS 5228 *Code of Practice for Noise and Vibration Control on Construction and Open Sites* – Part 2: *Vibration* (2009 +A1 2014) provides a guide of vibration sensitivities of differing types of sensitive equipment from microscopes to microelectronic manufacturing equipment, however these ranges are generic and relate to the sensitivity of the equipment as installed, not the external façade of the building. The most advisable approach for the control of potential vibration impacts at areas of vibration sensitive equipment or processes, is to review each location on its own merit in order to determine the site specific vibration limits taking into account any building or machinery isolation already in place. In this instance, where a receptor has been identified or made known within the study area that is potentially sensitive to vibration through questionnaires and consultations, this area is highlighted as one for consideration and consultation. In these instances, it is not possible to set specific vibration limits at this stage of the EIAR due to complexities in both the level of detail available at this stage and knowledge of the receptor. Further discussion on particularly sensitive equipment/processes are set out in **Section 17.6.1**.

17.2.2.2 Operational Phase

TII Noise Guidance Documents

There are no statutory guidelines relating to noise from road schemes in Ireland. In the absence of statutory guidance, the most commonly applied standard is that issued by the TII within their 2004 and 2014 noise guidance documents. Both documents specify that the following absolute noise design criterion for new national road schemes in Ireland is appropriate:

Day-evening-night value of: **60dB L_{den}.**

This is a free field façade criterion, i.e. does not take account of reflections from building facades.

L_{den} is the 24hour noise rating level determined by the averaging of the L_{day} with the $L_{evening}$ (plus a 5dB penalty) and the L_{night} (plus a 10dB penalty). L_{den} is calculated using the following formula:

$$L_{den} = 10log\left(\frac{1}{24}\right)\left(12 * \left(10^{\frac{Lday}{10}}\right) + 4 * \left(10^{\frac{Levening+5}{10}}\right) + 8 * \left(10^{\frac{Lnight+10}{10}}\right)\right)$$

Where:

- L_{day} is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the day periods of a year
- $L_{evening}$ is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the evening periods of a year
- L_{night} is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the night periods of a year

This criterion applies to new national roads. The following three conditions must be satisfied under the TII guidelines in order for noise mitigation to be provided:

a) The combined expected maximum traffic noise level, i.e. the relevant noise level, from the proposed road development together with other traffic in the vicinity is greater than the design goal of 60dB L_{den}

b) The relevant noise level is at least 1dB more than the expected traffic noise level without the proposed road development in place

c) The contribution to the increase in the relevant noise level from the proposed road development is at least 1dB

The proposed road development under consideration here is a new national road and hence the design goal and assessment methodology set out in the TII guidelines for the assessment of potential noise impacts from national road schemes are deemed directly applicable.

It should be noted that the design goal is applicable to new road schemes only. In addition, the design goal is applied to existing receptors in respect of both the year of opening and the Design Year, typically 15 years after projected year of opening. In the case of this proposed road development a commencement year of 2024 and a future Design Year of 2039 have been assessed.

Galway City and County Council Noise Action Plans 2013 - 2018

The Galway City Council and the County Galway Local Authorities Noise Action Plans (NAP) relates to the management of environmental noise in accordance with the Environmental Noise Directive (END) (202/49/EC). The purpose of the Action Plan is to manage and reduce, where necessary, environmental noise through the adoption of the action plans.

In the case of Galway City Council, noise due to road traffic sources from sections of roads with a traffic flow threshold above 3 million vehicle trips per annum were mapped in accordance with the second round of noise mapping studies within Europe. This applied to certain sections of the R336, R337, R338, R339, R446, R863, R864, R865, R866, R921, N6, N83, N59 and N84, which lie within the city boundaries.

Both NAPs have proposed the onset levels for assessment of noise management measures as follows.

- 70dB, L_{den}
- 57dB, L_{night}

The onset levels for noise management in addition to a decision matrix is used to identify those areas which may require noise intervention or management.

An implementation plan outlines a proposed programme of works for the period 2013 – 2018. The programme is largely dependent on traffic management and construction projects with the aim to reduce vehicle numbers and to re-distribute traffic on the road network of the city.

One of the management procedures referred to within both plans is mitigation through traffic planning. These specifically refers to a ring road for Galway City as a management procedure for reducing traffic volumes along existing routes across the city.

17.2.3 Data Sources and Consultations

Information relating to the proposed road development have been obtained primarily from the design team. Any comments that related to noise and vibration from consultations undertaken by the design team with stakeholders during the design development process were considered during the preparation of this chapter.

The following items of information were supplied by the design team which formed the main basis for the impact assessment:

- Background OS Mapping of the study area
- 3D ground contour mapping
- 3D road alignment drawings for the proposed road development
- Traffic flow forecasts for future opening and design years for study area
- Ongoing consultation feedback relevant to noise and vibration issues from interested and affected parties

- Landscaping proposals
- Construction plan information (compound locations, expected areas of blasting, construction traffic information etc.)

17.2.4 Study area and Baseline Data Collection

The study area for the noise and vibration impact assessment is focused on the areas likely to be affected by the operation of the proposed road development. This includes the closest noise/vibration sensitive locations along the route of the proposed road development in addition to those in proximity to existing roads in the vicinity of the proposed road development. Noise sensitive locations within a study area of approximately 300m from the centreline of the proposed road development was focused on for the baseline noise studies which is considered to capture the baseline noise environment at locations likely to be impacted by the proposed road development.

A comprehensive baseline noise study has been undertaken within the study area in order to provide a context of the typical noise environment and to determine the main contributors to the existing environment.

The surveying was completed in accordance with relevant guidance and standards including:

- Guidelines for the Treatment of Noise and Vibration in National Road Schemes (NRA, 2004)
- Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (NRA, 2014)
- Calculation of Road Traffic Noise Shortened Measurement Procedure (CRTN 1988)
- ISO 1996-2007 Acoustics – Description, Measurement and Assessment of Environmental Noise – Part 2 Determination of environmental noise levels. 1:2016

The survey locations were selected to represent the environments through which the proposed road development will pass which is predominately residential. Survey locations were therefore focused on residential areas set back from existing roads along the route of the proposed road development, residential estates, and residential properties located along local, regional and national roads. Additional surveys were undertaken at recreational facilities, schools and crèches, a church, a hospital, and commercial facilities. These were surveyed to gain information specific to these locations in addition to representing general ambient noise levels in the areas which they are located. Further details are set out in **Section 17.3**.

Unattended 24-hour monitoring stations were selected to represent specific noise environments (including those listed above) and a range of satellite attended measurement locations were monitored in the vicinity of these locations to characterise the noise environment within each area.

Given the extent of the baseline study area, it was not possible to gain access to all locations requested as part of the baseline study. In these instances, attended noise measurements were made at proxy locations to the nearest sensitive properties and unattended noise measurements were conducted, as far as practicable, at adjacent properties, depending on access being granted to private lands.

The surveying programme encompassed attended surveys at 73 locations and unattended surveys at 33 locations. A summary of results is presented and discussed in **Section 17.3**.

A survey of vibration levels along the corridor of the proposed road development was not undertaken, as levels associated with existing roads would not be expected to be of a magnitude sufficient to cause disturbance to people or structural damage to property. Furthermore, vibration was not perceptible at any of the noise survey locations. Comment on vibration sensitive equipment is set out in **Section 17.6.2.3**.

17.2.4.1 Unattended Measurements

The continuous measurements were conducted using a Brüel & Kjær UA 1404 Environmental Outdoor Kit, with either Brüel & Kjær Type 2238 or 2250 Sound Level Meters.

The measurement apparatus was check calibrated before and after each survey using a Brüel & Kjær Type 4231 Sound Level Calibrator. The results were saved to the instrument memory for later analysis.

Unmanned continuous measurements were conducted over at least 24-hour periods at thirty-three locations. L_{den} values are derived directly from the measured $L_{Aeq,1\,hour}$ measured data using the formula included in **Section 17.2.1**.

17.2.4.2 Attended Measurements

The short-term measurements were performed using Brüel & Kjær Type 2250 or 2260 Sound Level Meters. Short-term measurements were conducted at survey locations on a cyclical basis. Sample periods were 15 minutes. The results were noted onto a Survey Record Sheet immediately following each sample, and were also saved to the instrument memory for later analysis where appropriate. Survey personnel noted all primary noise sources contributing to noise build-up.

The survey work was conducted in accordance with the short-term measurement procedure as specified in the TII noise guidance documents.

When surveying traffic noise, the acoustical parameters of interest are $L_{A10(1hour)}$ and $L_{A10(18hour)}$, expressed in terms of decibels (dB) relative to 2x10-5Pa.

The value of $L_{A10(1hour)}$ is the noise level exceeded for just 10% of the time over the period of one hour. $L_{A10(18hour)}$ is the arithmetic average of the values of $L_{A10(1hour)}$ for each of the one-hour periods between 06:00 and 24:00hrs. $L_{A10(18hour)}$ is the parameter typically used in for the purposes of assessing traffic noise, where relevant.

The shortened measurement procedure involves a method whereby $L_{A10(18hour)}$ and L_{den} values are obtained through a combination of measurement and calculation as follows:

- Noise level measurements are undertaken at the chosen location over three consecutive hours between 10:00 and 17:00hrs
- The duration of the sample period during each hour is selected to encompass sufficient traffic flows to ensure reliable results
- The $L_{A10(18hour)}$ for the location is derived by subtracting 1dB from the arithmetic average of the three hourly sample values, i.e.

  $L_{A10(18hour)} = ((\sum L_{A10(15\ minutes)})\div 3) - 1$ dB
- The derived L_{den} value is calculated from the $L_{A10(18hour)}$ value, i.e.

  $L_{den} = 0.86 \times L_{A10(18hr)} + 9.86$ dB

The L_{den} is a long-term average indicator and represented the annual daily noise level.

The guidelines note that *where traffic is not the dominant noise source, then the normal correction cannot be applied to convert the 15 minute samples to an 18-hour value. However, it may be possible to derive a site specific correction from a nearby long-term site affected by the same noise sources. If there is not comparator site, a short-term measurement is inappropriate and a 24-hour measurement will be required.*

The baseline survey locations were selected in order to ensure that where traffic was not the dominant source at monitoring positions that an unattended 24-hour survey was conducted in order to directly derive a L_{den} from the measured data and satellite attended measurements were conducted in the vicinity of this location.

17.2.4.3 Monitoring Locations

The location of the surveyed baseline monitoring positions are presented in **Figure 17.1.01** to **17.1.14**. The majority of monitoring locations were positioned within gardens of residential properties or at proxy locations to residential locations in public areas where access to private lands were not possible. Additional surveys were undertaken at the Sporting Campus of NUIG (10b), Dangan House Commercial/Recreational (10c), St. James' Church, Bushypark (9g), Castlegar School (11i/11g), Ballybrit Industrial Estate (13a), Galway Clinic (14b) and Galway Racecourse (13h).

The location of the monitoring positions and the calculated L_{den} for each position is included in **Table 17.8** in **Section 17.3**. Baseline monitoring which are grouped in attended and unattended satellite locations are presented together. Full survey results for all locations are included in **Appendix A.17.1**.

17.2.4.4 Survey Periods

The baseline survey was undertaken over the course of the following dates:

- 10 February 2016
- 11 February 2016
- 23 February 2016
- 24 February 2016
- 25 February 2016
- 14 March 2016
- 15 March 2016
- 16 March 2016
- 22 March 2016
- 19 April 2016
- 20 April 2016
- 22 April 2016
- 31 May 2016
- 01 June 2016
- 02 June 2016
- 10 - 15 August 2017

17.2.4.5 Personnel and Instrumentation

The baseline surveys were undertaken by Enfonic and AWN Consulting Ltd. This involved installing all noise monitoring equipment at the monitoring locations and conducting the attended surveys.

17.2.5 Impact Assessment Methodology

17.2.5.1 Operational Phase Impact Assessment Process

The impact assessment methodology used for this chapter is based on the guidance contained within the 2004 and 2014 TII noise guidance documents and the EPA Draft Guidelines on the information to be contained in environmental impact assessment reports (Draft August 2017). The following methodology has been undertaken in accordance with the relevant guidelines:

- Characterise the existing baseline noise environment through environmental noise surveys
- Develop a 3D noise model of the study area and calculate noise levels for a baseline model to calibrate the model output

- Calculate the traffic noise levels at the nearest noise sensitive locations which are affected by the operation of the proposed road development for the following scenarios:
    - Do-Minimum – Opening Year (i.e. proposed road development is not built)
    - Do-Something – Opening Year (i.e. the proposed road development is built)
    - Do-Minimum – Design Year
    - Do-Something – Design Year
- In the case of this proposed road development, the Opening Year assessed is 2024 and the Design Year is 2039
- Assess the calculated noise levels for each scenario at the assessment locations to determine if the three conditions for noise mitigation have been met (Refer to **Section 17.2.2**). The cumulative impact assessment is incorporated into the modelling scenarios for the various scenarios defined above
- Where the three conditions for noise mitigation have been met, a review of potential noise mitigation measures is conducted for each assessment location to reduce noise levels to within the design goal, where practicable
- Determine the residual noise impacts taking into account the proposed mitigation measures at the sensitive locations along the route of the proposed road development
- Characterise the residual noise impacts of the proposed road development through reference to relevant criteria
- Assess the likely potential construction noise and vibration impacts associated with the short-term construction phase

17.2.5.2 Construction Phase Impact Assessment

Assessment of potential impacts during the construction phase is limited to information available at EIAR stage. Whilst the phasing of works and location of activities and work sites have been progressed to detailed stages as part of the EIAR, the specifics in terms of plant items, plant numbers, their locations and operational duration will be subject to site conditions, work scheduling and contractor proposals. In this instance, it is not possible to perform detailed calculations or detailed impact assessment for any one area given the variations in the items above on a week to week or day to day basis. It is however possbile to determine noise levels from typical construction activities associated with the various phases.

The TII Guidelines spefically note that there is limited information available on specific construction methods, numbers and types of plant before the appointment of a Contractor, which will normally happen after a scheme has been approved. The guidelines note that it is more appropriate to address the way in which potential construction impacts will be assessed and how they will be managed, including forms of mitigation and codes of practices that will be applied.

The guidelines do note, however, that areas of major earthworks or blasting should be noted and locations where particularly noisy activities such as piling (depending on the method used), rock breaking, and or night-works are identified.

The TII guidelines note that in the absence of an Irish or international standard relevant to construction noise, reference can be made to BS 5228 *-:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1 Noise* and Part 2 *Vibration.* This standard includes recommended methodologies for calculating construction noise levels and includes a range of best practice mitigation and management measures for the control of noise and vibration from construction sites.

In terms of calculation, this standard sets out sound power levels for a wide range of plant items normally encountered on construction sites, which in turn enables the prediction of indicative noise levels at distances from the works. The standard also includes empirical data on vibration levels measured at set distances from specific vibration generating activities in different ground and site conditions.

17.2.5.3 Operational Phase Impact Assessment

Noise Modelling

A computer-based prediction model has been prepared in order to quantify the traffic noise level associated with the operational phase of the proposed road development and associated road traffic changes on the surrounding network. This section discusses the methodology behind the noise modelling process.

Brüel & Kjær Type 7810 Predictor

Proprietary noise calculation software was used for the purposes of this impact assessment. The selected software, Brüel & Kjær Type 7810 Predictor, calculates traffic noise levels in accordance with the UK's Department of Transport, Calculation of Road Traffic Noise (CRTN) 1988 and relevant TRL correction procedures for calculating L_{den}.

Predictor calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- The magnitude of the noise source in terms of sound power or traffic flow and average speed
- The distance between the source and receiver
- The presence of obstacles such as screens or barriers in the propagation path
- The presence of reflecting surfaces
- The hardness of the ground between the source and receiver

Prediction of Traffic Noise

Noise emissions during the operational phase of the proposed road development have been modelled using Predictor using the CRTN methodology and the TRL 'Method 1' calculation procedure to calculate L_{den} values, using hourly traffic flows. The CRTN method of predicting noise from a road development consists of the following five elements:

- Divide the proposed road development into segments so that the variation of noise within this segment is small
- Calculate the basic noise level at a reference distance of 10 metres from the nearside carriageway edge for each segment
- Assess for each segment the noise level at the reception point taking into account distance attenuation and screening of the source line
- Correct the noise level at the reception point to take account of site layout features including reflections from buildings and facades, and the size of source segment
- Combine the contributions from all segments to give the predicted noise level at the receiver location for the whole proposed road development

Note that all calculations are performed to one decimal place. For the purposes of comparison with the design goal of 60dB L_{den}, the relevant noise level is to be rounded to the nearest whole number in accordance with TII guidance.

Model Inputs

The noise model was prepared using the following data:

- 3D road alignment drawings of the proposed road development supplied by the design team
- 3D topographical contour data for the surrounding study area incorporating the noise sensitive assessment locations
- background ordnance survey mapping
- the Annual Average Daily Traffic (AADT), % Heavy Goods Vehicles (HGV's) and traffic speeds

Modelled traffic data for the 'Medium Growth' scenario has been used for the noise impact assessment. Where noise mitigation was identified as a requirement for specific locations, however, the effectiveness of the mitigation was also tested against the 'High Growth' traffic scenarios to ensure a robust analysis.

Traffic flow data was provided for the Do-Nothing and Do-Something scenarios for the Opening Year of 2024 and Design Year of 2039. (Refer to **Chapter 6, Traffic Assessment and Route Cross Section**, for traffic figures used in the modelling exercise).

A standard road surface type, such as hot rolled asphalt (HRA), has been assumed for all roads as part of the base model development.

Model Calibration and Validation

The purpose of noise model validation is to ensure that the software is correctly interpreting the input data and providing results that are valid for the scenario under consideration. It should be noted that the purpose of the model validation is not to validate the prediction methodology in use as the CRTN prediction methodology has itself been previously validated.

Given the nature of the scale of the proposed road development in question, it was decided that the most appropriate mechanism for calibration would be to compare the output of a Predictor model scenario, using the AADT traffic flows for the existing road network in 2016, with the measured L_{den} values at the unattended survey locations in the vicinity of the existing national road network. The reason for choosing those survey locations along the existing national road network for the purposes of calibration, is to ensure that the noise environment was dominated by road traffic noise during the survey period. Noise levels calculated at 9 unattended locations in proximity to existing roads are presented in **Table 17.4** and compared against those measured during the baseline noise surveys. The variation in calculated noise levels is between 0 and ±1dB L_{den} at the assessment locations and hence is considered a strong correlation. It should be noted that the model results reflect road traffic noise only whereby the baseline noise environment has other contributing sources from other local roads, environmental conditions (leaf rustle, bird song etc.) industrial, commercial and or residential type sources, where relevant.

The results of the calibration are presented in **Table 17.4**.

Table 17.4: Model Calibration

Survey Location	Incident to road	Measured L_{den}, dB	Model Predicted L_{den}, dB	Variation (dB)
R1c	R336 Bearna	65	64	1
R3a	Na Foraí Maola	45	44	1
R9c	N59 Moycullen Road	62	61	1
R11g	School Road	52	52	0
R12e	N83 Tuam Road	72	72	0
R13d	Monivea Road R339 East	62	62	0
R14a	N6 Bóthar na dTreabh	57	56	1
R14b	R446	64	65	-1
R17b	N84 Headford Road	56	56	0

Receiver Locations

Free-field traffic noise levels have been predicted at a number of properties in the vicinity of proposed and existing roads. For single storey properties, noise levels are calculated to a height of 1.5m above ground. For multiple storey properties, the calculated noise level is made at the height of the most exposed window (e.g. first, second or third floor).

A total of 270 noise sensitive buildings have been considered in this assessment. For certain properties, receiver locations have been positioned at two or more locations around the building to assess noise levels associated with different facades facing different noise sources thus resulting in a total of 299 modelled receiver locations. The properties were selected on the basis of proximity to the existing and proposed roads. The modelled locations represent the closest noise sensitive locations to the proposed road development and along sections of the existing road network where traffic volumes are modelled to change as a result of the proposed road development. Receptor locations were positioned at locations representing clusters or rows of properties where a number of noise sensitive buildings are in close proximity to each other.

The locations of all receptors are shown on **Figure 17.1.001** to **17.1.114**.

<u>Model Output</u>

The output of the model is a calculated traffic noise levels in terms of the L_{den} parameter at specific modelled receiver locations.

Four scenarios have been considered as follows:

- Year 2024 – Do-Minimum (i.e. proposed road development is not built)
- Year 2024 – Do-Something (i.e. proposed road development in place)
- Year 2039 – Do-Minimum
- Year 2039 – Do-Something

<u>Criteria for Noise Mitigation</u>

The calculated noise levels at each modelled location are reviewed and compared against the three criteria for noise mitigation set out in the TII noise guidance documents as included in **Section 17.2.2.2**.

Where modelled locations are determined to meet the three criteria, the use of noise mitigation has been recommended to reduce noise levels to within the relevant design criterion.

Evaluation of Potential Noise Impacts

There are no guidelines in Ireland for assigning significance criteria for new road developments. The TII Guidance for noise does not prescribe a methodology for evaluating the magnitude or significance of road traffic noise from a new road development. The use of an absolute criterion is used as a threshold value above which noise mitigation measures are to be provided, assuming the 3 conditions for noise mitigation are met. The 60dB L_{den} design goal takes into consideration the alignment of the majority of new national roads in Ireland across a range of different environments including rural, semi-rural, suburban and urban locations.

In order, therefore, to evaluate the potential significance of the noise levels associated with the operation of the proposed road development, consideration needs to be given to issues such as the absolute level of noise under consideration, the magnitude of change in noise levels at a given location and the receptor sensitivity. Comment on potential night-time noise exposure should also be considered.

Magnitude of Change

In the absence of any Irish guidelines or standards relating to describing the effects associated with changes in road traffic noise levels, reference has been made to the UK's Design Manual for Roads and Bridges. Volume 11 Section 3 Part 7 (2011). This document provides suggested magnitude rating tables relating to changes in noise levels associated with road traffic noise. The document suggests that during the year of opening, the magnitude of impacts between the Do-Minimum and the Do-Something scenarios are likely to be greater compared to the longer term period when people become more habitualised to the source.

This document suggests that changes in noise levels between the Do-Minimum and Do-Something scenarios for the year of opening are compared and categorised in line with the 'short term' table reproduced in **Table 17.5**. Longer term impacts are assessed by comparing the Do Minimum noise level calculated for the opening year against the Do Something scenario for the design year (typically 15 years after opening) as reproduced in **Table 17.6**.

It should be noted the tables below relates to the $L_{A10,18hr}$[1] parameter as opposed to the L_{den} which is the assessment parameter for road traffic noise in Ireland.

Table 17.5: Classification of Magnitude of Noise Impacts in the Short Term

Noise Change, dB(A)	Magnitude of Impact
0	No Change
0.1-0.9	Negligible
1 – 2.9	Minor
3 – 4.9	Moderate
5+	Major

Table 17.6: Classification of Magnitude of Noise Impacts in the Long Term

Noise Change, dB(A)	Magnitude of Impact
0	No Change
0.1 – 2.9	Negligible
3 – 4.9	Minor
5 – 9.9	Moderate
10+	Major

Whilst the DMRB magnitude of change tables are a means of assigning an objective rating against a change in noise levels, it is important to note the following limitations of this approach:

[1] This parameter refers to the $L_{A10,18hr}$ parameter which is typically equivalent to L_{den} when free field conditions are considered. The $L_{A10,18hr}$ includes a façade correction which broadly equivalent to L_{den} (free field) plus 2.5dB.

- The DMRB notes the method used to assess magnitude of change significance is based on surveys conducted at sites where road traffic was the dominant noise source with noise exposure levels in the range of 65 to 78dB $L_{A10,18h}$, with the changes in traffic noise being up to 10dB $L_{A10,18h}$ at dwellings up to 18m from the roadside kerb. The document states that on this basis this method should be used with caution.
- Reliance on calculated ‘Do Minimum’ noise levels to represent noise levels in the absence of the proposed road development will result in artificially low base levels at some receptors, particularly in rural settings set back from modelled roads.
- Reference to the baseline measured noise levels is required to verify the pre-existing noise environment.
- Whilst a significance rating is applied to a change in noise level based on the above information, the absolute noise level is an important consideration when determining the response to noise levels from the population at large. This is particularly valid for locations where ‘major’ ratings are applied against comparably low absolute noise levels.

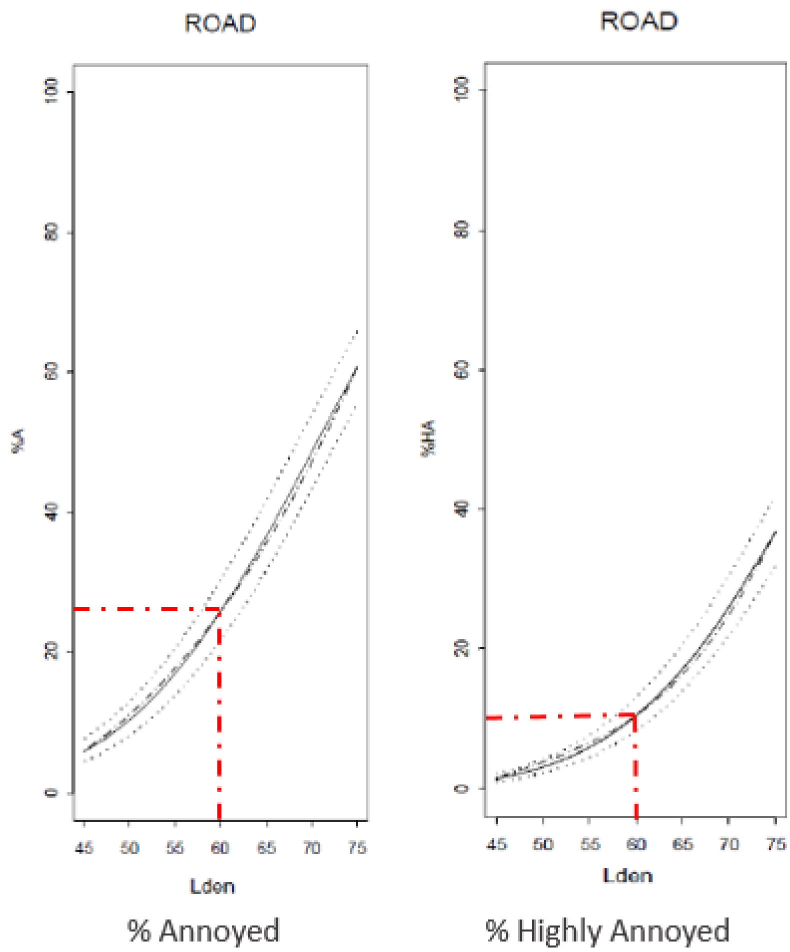
Commentary on Absolute Noise Level

The absolute noise level associated with the proposed road project is another important consideration when evaluating the impacts of the proposed road development. In instances where an increase of noise levels of +5dB(A) are calculated during the year of opening, resulting in a ‘major’ significance rating, for example, the actual level of traffic noise at the property may still be below a level considered to cause any significant effect.

In order to provide some context on the potential level of annoyance associated with road traffic noise, reference is made to the European Environmental Agency (EEA) publication ‘Good Practice Guide on Noise Exposure and Potential Health Effects’ (EEA Technical Report 11/2010). This document provides exposure-response relationships relating to different noise source types. Figure 3.1 of the document presents the percentage of the population defined as being ‘annoyed’ and ‘highly annoyed’ by road traffic noise based on European wide studies. The parameter referred to in the study is L_{den} which is directly comparable to the parameter assessed as part of this proposed road development.

The annoyance figure is reproduced in **Plate 17.1** with the 60dB L_{den} value illustrated against which the proposed road development has been assessed.

Plate 17.1: Percentage of People Annoyed by Road Traffic Noise



The figure indicates that at a road traffic noise level of 60dB L_{den}, 26% of the population have the potential to be 'annoyed' and 10% 'highly annoyed'. The report notes that for roads with quiet road surfaces, there is a decrease in reported annoyance response compared to those in the response curves.

<u>Night-time Noise Levels</u>

Noise levels relating to the proposed road development are assessed in terms of the L_{den} parameter which includes day, evening and night-time noise levels with the relevant penalties included for evening and night-time periods. The TII noise documents do not specify a separate design goal for night-time periods, however it is important to note that night-time noise levels are encompassed within the overall 60dB L_{den} deign goal.

The following relevant documents provide guidance on night-time noise levels:

- The Galway City and Galway Council Noise Action plans (2013 – 2018) sets night-time onset levels of 57dB L_{night} as a threshold for consideration for noise management.
- The WHO Night Noise Guidelines for Europe (NNG 2009) sets an Interim Target of 55dB L_{night}, outside.

- The DMRB notes that night-time road traffic noise levels below 55dB are not included in a relative change assessment as they fall below the WHO Night Noise Guidelines for Europe (NNG 2009) Interim Target of 55dB L_{night}, outside.
- The DMRB recommends that changes in noise levels are assessed for locations with a road traffic noise level in excess of 55dB L_{night}. At these locations, the magnitude of noise change is determined using the 'Long term' classification tables.

Receptor Sensitivity

Other considerations relating to the evaluation of impacts is the sensitivity of the receptor under consideration. The following sensitivity is proposed for the property types along the route of the proposed road development.

Table 17.7: Classification of Receptor Sensitivity to Noise

Sensitivity of Receptor	Description
High	Residential properties, hospitals, nursing homes, educational buildings (daytime)
Medium	Places of worship, community facilities, amenity areas
Low	Commercial and industrial premises

The noise sensitive receptors assessed along route of the proposed road development are predominately residential properties. There are two schools (St. James' National School, Bushypark and Castlegar School, on School Road) a nursing home on School Road and Galway Clinic along R446 Road, all of which are categorised as High Sensitive receptors.

One church (St. James' Church, Bushypark) is included in the assessment which is defined as a medium sensitive receptor. The community facilities and amenity areas of the NUIG Sporting Campus and Galway Racecourse are also included in the assessment and are considered to be of medium sensitivity. A small number of commercial premises are assessed along the N83 Tuam Road and Parkmore and Ballybrit area and are defined as being of low noise sensitivity. Vibration sensitive locations are addressed separately.

The above information will be used as a basis for evaluating potential noise impacts from the proposed road development.

17.3 Receiving Environment

The receiving environment for the proposed road development is a mixture of semi-rural and suburban lands on the fringes of Galway City. In the case of a road development, the selected noise-sensitive locations are those in closest proximity to the proposed road development and those along existing roads which are being traversed by the proposed road development. Both the construction and operational phases of the proposed road development are reviewed when selecting appropriate measurement locations.

17.3.1 Summary of Survey Results

A summary of the measured and derived L_{den} values for each monitoring location is presented in **Table 17.8** below. The baseline monitoring which are grouped in attended and unattended satellite locations are presented together for each area.

Full survey results for all attended and unattended survey locations, along with the derived L_{den} values, are presented in **Tables A.17.1.1** to **A.17.34** in **Appendix 17.1**.

Table 17.8: Summary of Baseline Survey Results

Location	Survey Type	Location	Calculated L_{den}	Location	Survey Type	Location	Calculated L_{den}
1c	Unattended	Along R336, Bearna	65	4a	Unattended	Troscaigh	43
1a	Attended		60	4b	Attended		47
1d	Attended		67	4c	Attended		48
1e	Attended		66	4d	Attended		43
1f	Unattended	Na Foraí Maola	47	4e	Attended		46
2d	Attended		48	4f	Attended		49
1b	Attended		44	5a	Unattended	Ballard West	50
2c	Attended		43	5b	Attended	Ballard West	49
2b	Attended		44	5c	Attended	Ballard West	46
2a	Unattended		43	5d	Unattended	Cappagh Road	52
2f	Attended		45	5e	Attended	Cappagh Road	48
3c	Attended	Na Foraí Maola	48	5f	Attended	Cappagh Road	52
3e	Attended		46	6a	Unattended	Ballyburke/Ballymoneen Road	43
3a	Unattended		45	6b	Attended	Ballyburke/Ballymoneen Road	45
2e	Attended		52	6c	Attended	Ballymoneen Road	64
3b	Attended		45	6d	Attended	Ballymoneen Road	53
3d	Attended		45	7b	Unattended	Árd na Gaoithe, Ballymoneen	44

Location	Survey Type	Location	Calculated L_{den}	Location	Survey Type	Location	Calculated L_{den}
3f	Attended		42				
7a	Unattended	Rahoon Road	46	9h	Unattended	Knockadoney	56
7c	Attended		57	9i	Attended	St James' Church/N59 Moycullen Road	58
7d	Attended		58	18f	Attended	N59 Moycullen Road	71
7e	Attended		51	18e	Attended	N59 Moycullen Road	68
7f	Attended		64	18b	Attended	N59 Moycullen Road	63
8a	Attended	Rosán Glas/N59 Link Road. Letteragh	45	18c	Attended	N59 Moycullen Road	66
8b	Attended		63	10a	Unattended	Aughnacurra	53
8c	Unattended	Letteragh Road	51	10h	Attended	Aughnacurra	51
8c	Attended		51	10b	Attended	NUIG Sporting Campus	52
8f	Attended		56	10c	Unattended	Dangan House	49
8d	Unattended	An Chloch Scoilte	50	10d	Unattended	Menlo/Coolough	51
8e	Attended		49	10e	Attended	Menlo/Coolough	47
8g	Unattended	Knocknabrona	47	10f	Attended	Menlo/Coolough	54
9a	Unattended	The Heath/Upper Dangan	54	10g	Attended	Coolough Road	63
9b	Unattended		47	11a	Unattended	N84 Headford Road	54
9d	Attended		58	11b	Attended		66
9e	Unattended		53	11c	Attended		78
9f	Attended		71	17b	Unattended		56

Location	Survey Type	Location	Calculated L_{den}	Location	Survey Type	Location	Calculated L_{den}
9c	Unattended	Upper Dangan/N59 Moycullen Rd	62	17a	Attended		77
9g	Attended	N59 Moycullen Road	64	13a	Unattended	Ballybrit, Racecourse Avenue	50
11d	Unattended	Bóthar an Chóiste/Castlegar	47	13b	Attended		57
11f	Attended	Bóthar an Chóiste/Castlegar	50	13c	Unattended	Ballybrit Crescent	57
11e	Attended	Bóthar an Chóiste/Castlegar	54	13d	Unattended	R339 Monivea Road East	62
12b	Attended	School Road-Castlegar	45	13e	Attended	Briarhill N6 Coolagh Junction	61
11g	Unattended	School Road - rear of house	52	13f	Attended		63
11h	Attended	School Road - front of house	56	13g	Attended		66
11i	Attended	School – Castlegar, front of building	63	13h	Unattended	Galway Racecourse, Ballybrit	53 - 63
12c	Attended	School Road South (close to road)	67	14a	Unattended	Coolagh, east of N6 Coolagh Junction	56
12a	Unattended	N83 Tuam Road Junction South	61	14c	Attended		50
12d	Attended		48	14e	Attended		48

Location	Survey Type	Location	Calculated L_{den}	Location	Survey Type	Location	Calculated L_{den}
12e	Unattended	N83 Tuam Road Junction North	72	14b	Unattended	R446 Doughiska - Galway Clinic	64
16a	Attended	N83 Tuam Road North	77	15a	Attended	N6 South of Ballybrit – The Meadows Estate, on green	54
16b	Attended	N83 Tuam Road North	65	15b	Attended	Along Monivea Road	72
16c	Attended	N83 Tuam Road North	68	15c	Attended	South of existing N6 on green	61

17.3.2 Discussion of Baseline Environment

The results of the baseline surveys indicate the range of noise levels measured across the extent of the study area.

17.3.2.1 R336 Coast Road to Cappagh Road (Ch. 0+000 – 4+450)

At the western end of the proposed road development at properties along the R336 Coast Road, noise levels are dominated by traffic flows along this road. Noise levels were measured in the range of 60 to 67dB L_{den}, the main difference in the measured levels being the proximity to and line of sight from the road of the monitoring position.

Within Na Foraí Maola, residential properties are set back from heavily trafficked roads such as the R336 Bearna Road at distances of approximately 200m to 1km and are influenced predominately by local passing traffic, local activities within the residential areas and environmental sources including bird song, leaf rustle etc. Noise levels were measured in the range of 42 to 52dB L_{den} at the surveyed locations. The higher noise levels measured in this area were typically associated with intermittent local sources during the surveys, e.g. local deliveries to properties (post-delivery, oil deliveries, garden activities etc.).

Surveyed locations in the vicinity of Troscaigh and Ballard West were measured in the range of 43 to 50dB L_{den}.. Noise levels at the surveyed locations were noted to be influenced by passing traffic along the local roads in proximity to the monitoring positions in addition to local activities within gardens and bird song.

17.3.2.2 Cappagh Road to Rahoon Road (Ch. 4+450 – 6+650)

Noise monitoring locations within the gardens of properties in the vicinity of Cappagh Road, Ballymoneen Road and Árd Na Gaoithe in Ballymoneen set back from passing traffic were measured in the range of 43 to 45dB L_{den}. Noise levels at property facades located along the Cappagh and Ballymoneen Roads, were of the order of 52 and 53dB L_{den}. The highest noise level measured in this area was at monitoring location 6c which was measured at the front gate of a property along the footpath which was dominated by passing traffic, an L_{den} noise level of 64dB was measured at this location.

Surveyed properties along the Rahoon Road were measured in the range of 46 to 64dB L_{den}. At survey locations set back from the existing road and screened from passing road traffic by the property buildings, noise levels were measured in the range of 46 to 51dB L_{den}. At locations located in closer proximity to the existing road, noise levels were in the range of 57 to 64dB L_{den}, the higher noise level being recorded at location 7f which was noted to be influenced by passing road traffic.

17.3.2.3 Rahoon Road to N59 Moycullen Road (Ch. 6+650 – 8+550)

Noise levels at two areas in the vicinity of Rosán Glas within Letteragh were surveyed. At survey location 8a an L_{den} value of 45dB(A) was derived. Noise levels at this location were influenced mainly by intermittent passing vehicles entering the estate along Bóthar Diarmuida and bird song. At location 8b passing traffic was noted to be significantly more frequent and the monitoring location closer to the road side. In addition, a greater level of local estate activities was noted resulting in noise levels of 63dB L_{den} being measured at this location.

Noise levels measured in the vicinity of Letteragh Road and Knocknabrona were measured 47 to 56dB L_{den} (survey locations 8c to 8g). Similar to the above areas, at survey locations set back from passing road traffic, lower noise levels were measured, typically in the range of 47 to 51dB L_{den} which were noted to be influenced by distant and intermittent passing traffic and bird song. The highest noise level of 56dB L_{den} was measured at location 8f due to the proximity and line of sight to passing road traffic.

In the vicinity of the proposed N59 Letteragh Junction and proposed River Corrib Bridge, noise levels varied at the surveyed locations depending on their distance to existing road traffic. At monitoring locations within The Heath and Knockadoney within Upper Dangan (9a, 9b & 9e), noise levels were measured in the range of 47 to 58dB L_{den}. At all locations road traffic from the N59 Moycullen Road and birdsong was noted to be the main noise sources noted. Higher noise levels were recorded at properties located closer to the N59 Moycullen Road (i.e. location 9d & 9c) measuring noise levels in the range of 58 to 62dB L_{den}.

Properties directly accessing the N59 Moycullen Road (9g, 9f, 18b, 18c, 18e and 18f) measured highest noise levels in this area, ranging between 63 to 71dB L_{den} depending on the proximity of the measurement position to the existing road.

17.3.2.4 N59 Moycullen Road to Menlough (Ch. 8+550 – 11+000)

In the vicinity of NUIG Sporting Campus and Aughnacurra (10a, 10b, 10c and 10h), measured noise levels were recorded in the range of 49 to 53dB L_{den} which were noted to be influenced predominately by distant road traffic, grounds works, birdsong and plant noise from an adjacent business campus. Similar noise levels were recorded in the vicinity of Menlough and Coolough (locations 10d, 10d and 10f) in were the range of 47 to 54dB L_{den} which were noted to be influenced by intermittent traffic, bird song, dog barking and leaf rustle. Higher noise levels were recorded at Location 10g (63dB L_{den}) due to the proximity of the monitoring location to the road.

17.3.2.5 Menlough to N83 Tuam Road (Ch. 11+000 – 14+450)

To the east of Coolough the proposed development passes through a more built up environment crossing a number of main routes into Galway City, namely the N84 Headford Road, N83 Tuam Road and existing N6.

In the vicinity of the N84 Headford Road and proposed new junction, noise levels were measured in the range of 54 to 77dB L_{den}. Noise levels of 54 and 56dB L_{den} were recorded at the unattended monitoring positions located to the rear and side of properties set back from the N84 Headford Road (locations 11a and 17b). Higher noise levels were measured to the front of properties facing directly into the existing road with survey locations 17a and 11c recording highest levels due to their close proximity to the existing road.

Within the area of Castlegar, noise levels were measured in the range of 45 to 54dB L_{den} which were noted to be influenced by road traffic from School Road, the N84 Headford Road and from passing local traffic. Properties located off School Road measured noise levels in the vicinity of 63 to 67dB L_{den} when measured at the property boundaries in close proximity to the existing road. At monitoring locations set back from the road edge, noise levels measured 56dB L_{den} (11g) and were lower again at the rear of properties along this road shielded by road traffic noise (11g), measuring 52dB L_{den}.

Noise surveys undertaken at properties in the vicinity of the proposed N83 Tuam Road Junction were predominately influenced by traffic along the N83 Tuam Road. Monitoring locations fronting properties along this existing road were in the range of 61 to 77dB L_{den} (locations 12a, 12e, 16a, 16b and 16c). Lowest noise levels in this area were recorded at location 12d (48dB L_{den}) which is set back from the N83 Tuam Road and was shielded from the road traffic by local topography.

17.3.2.6 N83 Tuam Road to Coolagh Junction (Ch. 14+450 - 17+500)

Noise surveys conducted in the area of Ballybrit and Briarhill ranged between 50 and 57dB L_{den} (locations 13a, 13b, and 13c). Higher noise levels were recorded at locations 13b and 13c due to their proximity to road traffic from Ballybrit Crescent and local passing traffic.

At surveyed locations along the R339 Monivea Road and the existing N6 in the vicinity of the Ballybrit and Doughiska (locations 13d, 13e, 13f, 13g, 14b), noise levels were measured in the range of 61 to 66dB L_{den} which were all influenced by passing road traffic.

Within Galway Racecourse, noise levels presented represent those when no race activity was taking place. This represents lowest noise levels in this area when the facility is typically not in use. Noise levels were measured in the range of 53 to 63dB L_{den} over a 5 day monitoring period.

To the east of the proposed Coolagh Junction within Coolagh (locations 14a, 14c and 14e), noise levels were measured in the range of 48 to 56dB L_{den}. The dominant sources at these locations were noted to be road traffic and birdsong.

At survey locations along the R339 Monivea Road to the south of the existing N6 (locations 15a, 15b and 15c) noise levels were measured in the range of 54 to 72dB L_{den}. Lowest noise levels were measured at location 15a which was positioned within a green area fronting houses within The Meadows Estate which was shielded from road traffic. Highest noise levels were recorded at locations 15b due high volumes of traffic passing along the R339 Monivea Road in addition to the existing N6.

17.3.3 Summary of Noise Survey Results

The results of the baseline noise survey indicate that the noise environment varies across the proposed road development depending on the surrounding noise sources. In general, properties facing directly onto existing roads are dominated by road traffic and experience noise levels in excess of 60dB L_{den}. Properties in more rural settings set back from road traffic experience noise levels typically in the range of 42 to 50dB L_{den} depending on local sources in the vicinity.

The range of noise levels measured during the baseline surveys are an accurate representation of the baseline noise environment at properties likely to be affected by the proposed road development.

17.4 Characteristics of the Proposed Road Development

17.4.1 Construction Phase

The construction phase of the proposed road development will involve predominately ground breaking, earthworks and earthworks haulage, drainage works, construction of drainage ponds and surfacing works, construction of tunnels, bridges and overpasses, as well as the movement of machinery and materials within and to and from the construction compounds and along local roads.

A variety of items of plant will be in use during these construction works all of which have the potential to generate high levels of noise and potential levels of perceptible vibration. These will include breakers, rock drills, excavators, dump trucks, and generators in addition to general road surfacing and levelling equipment.

Blasting of bedrock will also be required on certain sections of the proposed road development depending on the ground conditions and the required depth of excavations. **Chapter 7, Construction Activities** provides a full description of the proposed construction phasing and works for the proposed road development.

It is envisaged that an east to west build will be adopted and construction may be completed in two concurrent phases or a single overall contract:

- Phase 1 – N6 Coolagh to N59 Letteragh Junction – 9.9km (Including the N59 Link Road North and South.)
- Phase 2 – N59 Letteragh Junction to R336 Coast Road west of Bearna -7.5km

In general, road building works by their nature are transient in nature as the works progress along the length of the route of the proposed road development. This includes excavation and fill works, structures, and road completion works. Site compounds in phases 1 and 2 will be set up typically at the commencement of the works and remain in place until all construction in the area is completed.

Within each phase, it is likely that the main construction work for the proposed road development will be split up into different sections along the route of the proposed road development. For the purposes of the EIAR, 15 individual construction sections are set out. Sections may be completed simultaneously and combined in certain areas. **Table 7.1** in **Chapter 7, Construction Activities** includes a summary of each section with the estimated time for the completion of works in these areas.

Typical working hours during the construction phase will be:

- 0700 1900 Monday – Friday
- 0700 1600 Saturday

It will be necessary to work overtime (including weekends) and night shifts at certain critical stages during the project. There may be some periods where 24hr work and supervision is required. Over the expected 36 month construction phase there will be up to 10 weeks of night time working along different sections of the proposed road development primarily to facilitate bridge works over existing roads.

The potential noise and vibration impacts associated with this phase are set out within **Section 17.5.3**.

17.4.2 Operational Phase

The operational phase will involve a new road alignment, junctions, overpasses, tunnels and bridges as part of the proposed road development. The proposed road development will introduce traffic noise to areas which are not currently exposed to any significant level of road traffic, particularly at properties set back from existing local roads in rural settings. The character of the noise environment will be altered at properties where intermittent traffic forms part of the noise environment to a more continual source of noise as a result of the operational phase. In addition to the above, the proposed road development will divert traffic flows from sections of existing roads across the city and hence, will result in a reduction in traffic noise along sections of these roads once operational.

The operational phase will be of long term duration and will alter the existing noise environment at properties in proximity to the proposed road development and along existing roads to different extents.

The potential impacts associated with this phase are set out within **Section 17.5.4**.

17.5 Evaluation of Impacts

17.5.1 Introduction

The potential impacts of noise and vibration as a result of the proposed road development will vary depending on the proximity of sensitive locations to the proposed road development, the pre-existing noise levels in the area and the duration of the impacts considered. It is estimated that the overall construction period will last for approximately 36 months. During the construction phase, potential noise and vibration impacts will be more significant compared to the operational phase but the duration will be short-term in nature. The operational phase will result in long-term effects but the significance of which will vary depending on the sensitivity of the existing environment and the magnitude of change against the Do-Minimum scenario, and the absolute noise levels under consideration.

17.5.2 Do-Nothing Impact

The Do-Nothing impact of the proposed road development assumes the proposed road development is not built and traffic management plans within the Galway city area are not in place. In line with traffic growth factors, traffic volumes will continue to increase along the existing routes accessing Galway City as part of the Do-Nothing Scenario. From a noise point of view, this will result in increased noise levels over and above the current scenario at properties located along the main national and regional roads. At properties set back from trafficked roads, noise levels measured as part of the baseline survey are expected to remain broadly similar. Noise levels at properties identified as 'hot spots' and areas for noise management within the Galway City Noise Action Plan (2013 – 2018) will remain above the threshold noise levels for noise management and are likely to be further increased as a result of increased traffic volumes.

17.5.3 Potential Construction Impacts

17.5.3.1 Noise

As per TII guidance, indicative ranges of noise levels associated with construction may be calculated in accordance with the methodology set out in *BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Noise*. This standard sets out sound power levels for plant items normally encountered on construction sites, which in turn enables the prediction of noise levels. However, it is not possible to conduct detailed accurate prediction calculations for the construction phase of a project in support of the EIAR due to the limitations previously discussed in **Section 17.2.5**. The following section discusses typical noise levels associated with road construction activities and comments on potential noise impacts across the proposed road development.

Intrusive Works and High Noise Activities

Reference to BS 5288:2009+A1 2014: Part 1 indicates that highest noise levels are associated with activities associated with rock breaking, rock drilling, rock crushing and some impact piling works. Noise levels from these activity types are typically in the range of 85 to 95dB L_{Aeq} at 10m. All of the above activities will be required as part of the construction of the proposed road development.

For construction activities associated with rock extraction and processing a total construction noise level of 93dB L_{Aeq}, at 10m has been used for the purposes of indicative calculations. This would involve for example, 1 item of plant at 90dB L_{Aeq} and 3 items of plant at 85dB L_{Aeq} operating simultaneously within one work area which is considered a worst-case scenario.

Utilities, Bulk Excavation, Bridge Works & Road Works

For construction works associated with activities such as site clearance, excavation and fill, bridge works etc. including excavators, loaders, dozers, cranes, generators, concreting works etc. noise levels are typically in the range of 70 to 80dB L_{Aeq} at 10m.

For ongoing construction activity associated with the above activities, a total construction noise level of 85dB L_{Aeq} at 10m has been used for the purposes of indicative calculations. This would include, for example two items of plant at 80dB L_{Aeq} and three items of plant at 75dB L_{Aeq} operating simultaneously within one work area.

Compounds and Lower Noise Activities

For construction work areas with lower noise levels such as site compounds (for storage, offices and material handling, generators etc.), smaller items of mobile plant (excavators, cranes, dozers), landscaping and concreting works with lower noise emissions, a total construction noise level of 78dB L_{Aeq} at 10m has been used for the purposes of indicative calculations. This would include, for example one item of plant at 75dB L_{Aeq} and three items of plant at 70dB L_{Aeq} operating simultaneously within a work area.

Given the variations of on-site activities and noise levels over any one day and considering that all activities will not operate simultaneously, the values noted above are considered robust for the purposes of assessing potential construction impacts.

The closest properties to the proposed road development which are not being acquired or demolished are at distances of approximately 20m. Remaining properties are located at distances of 50 to >300m from different work phases.

Table 17.9 presents the calculated noise levels at distances between 20 and 250m representing the closest noise sensitive properties to the construction works. The calculations assume that plant items are operating for 66%[2] of the time and do not

2 This estimate that assumes that the plant will operate a full 8-hour shift over the proposed 12 hour working period which equates to a 66% on time over a daytime period or 40 minutes over a 1-hour period. The dynamic nature of construction sites is such that this is deemed to be a conservative estimate, particularly for breaking and drilling work.

include any attenuation from screening of site hoarding, road cuttings, buildings or structures, hence relate only to distance attenuation over hard ground.

Table 17.9: Indicative construction noise calculations at varying distances

Construction Activities	Combined LAeq at 10m	Calculated Noise Level at Increasing Distances					
		20m	50m	80m	100m	150m	250m
Rock Breaking / Drilling / Rock Crushing / Impact Piling	93	85	77	73	71	68	63
Site Clearance Utilities Excavation & fill Structures Road Works	85	77	69	65	63	60	55
General site work	77	69	62	57	55	52	48

The reference values outlined in **Table 17.9** indicate that for construction activities with highest noise levels (L_{Aeq} up to 93dB at 10m), the daytime construction noise limit value of 70dB L_{Aeq} Monday through Friday (07:00 to 19:00hrs) is likely to be exceeded at distances of up to 100m from the works boundary in the absence of any noise mitigation. Evening and weekend construction noise limits would be exceeded at distances up to 250m in the absence of noise mitigation. Noise mitigation will therefore be required to reduce construction noise levels from this type of activity during all periods at the closest properties.

During normal road construction works including site clearance, bulk excavation, structures etc. with site works up to 85dB L_{Aeq} at 10m, the daytime construction noise limit value of 70dB L_{Aeq} Monday through Friday (07:00 to 19:00hrs) is likely to be exceeded at distances of up to 50m from the works boundary in the absence of any noise mitigation. Evening and weekend construction noise limits would be exceeded at distances up to 150m in the absence of any mitigation. Noise mitigation will therefore be required to reduce construction noise levels from this type of activity, particularly during any scheduled evening and weekend works.

During general site work with lower noise emissions (L_{Aeq} up to 77dB at 10m) the daytime construction noise limit value of 70dB L_{Aeq} Monday through Friday (07:00 to 19:00hrs) can be complied with at distances of 20m and beyond. Evening and weekend construction noise limits would be exceeded at distances up to 80m in the absence of any mitigation. Noise mitigation will therefore be required to reduce construction noise levels from this type of activity, specifically during any scheduled evening and weekend works.

It should be noted that the calculations set out in the above tables are indicative and are used for the purposes of comparison only with the adopted criteria. Where exceedance of the recommended criteria is expected, the use of noise mitigation measures will be used as part of the construction works. Further details are set out in **Section 17.6.1**.

In line with the TII Guidelines on assessment of construction noise impacts, areas of major earthworks, blasting and piling (depending on the method to be used) should be identified. In addition, given two tunnel sections form part of the proposed road development, discussion of these areas should be included also. These are discussed in turn below.

Major Earthworks

Areas of major earthworks are associated with large cuttings and embankment constructions involving activities including excavation works, drill and blast techniques, rock crushing and fill works.

Moving west to east, construction of the mainline of the proposed road development below the Aille Road L5384 (Construction Section S2) will require a substantial amount of material excavation most likely using drill and blast techniques. Given the extent of the work in this area, it is likely that excavated material will be segregated, graded and crushed using mobile plant items within the excavated area. The closest properties to these works are some 120m from the earthworks boundary. During the early stages of construction in this area, there is potential for construction noise levels to exceed the noise criteria in the absence of any noise mitigation assuming rock drilling, crushing and a number of mobile plant items are operating at existing ground level. As the excavation works progress, the lowered ground level and screening from the cutting will significantly reduce noise levels at the closest properties.

Construction of the Letteragh Junction and approach roads (Construction Section S3 and S4) will require a substantial volume of engineering fill and an element of cutting for slip roads. Closest noise sensitive locations are between 50m and 60m from these junction works. In the absence of specific noise mitigation measures, there is potential for evening and weekend construction noise criteria to be marginally exceeded, should works occur during these time periods.

Construction of the N59 Link Road North (Construction Section S5) involves deep excavation towards the N59 Moycullen Road tie in, therefore a substantial volume of soil and rock excavation will be required which will likely require drill and blasting excavation. Closest noise sensitive locations are approximately 50 from the excavation works. In the absence of specific noise mitigation measures, it is likely that construction noise limits during, day, evening and weekend periods will be exceeded, specifically during the intermittent use of high noise activities (rock drilling, crushing and breaking, if required). The use of specific noise mitigation measures will be applied in this area therefore including scheduling of works, choice of plant, screening etc. Further discussion on mitigation measures are discussed in **Section 17.6.1**.

Construction of the N59 Letteragh Junction (Construction Section S6) involves an extensive area of cuttings which will likely require drill and blast excavation. Closest noise sensitive locations are approximately 25m from the excavation works. Whilst excavation works will take place within the cutting area, it is likely that crushing and regrading works will take place within a specific site compound located along the N59 link Road North, set back from noise sensitive properties. Notwithstanding the above, given the close distances of excavation works to noise sensitive properties, the use of controlled noise mitigation measures will be required in this area to reduce construction noise levels at the nearest noise sensitive locations.

Construction Section S10 involves construction of a large embankment connecting to the Menlough Viaduct. Moving east, construction of the dual carriageway will involve a deep cutting as it approaches the Lackagh Tunnel. The closest noise sensitive properties in this area are approximately 40m from the embankment works but are over 300m from the excavation works for the cutting. In the absence of specific noise mitigation measures, there is potential for evening and weekend construction noise criteria to be marginally exceeded, should works occur during these time periods.

Construction of the Lackagh Tunnel (Construction Section S11) will be undertaken in an east to west direction using drill and blast techniques. The tunnel portal and main works area will be within the Lackagh Quarry site compound. The closest noise sensitive properties to the tunnel are over 500m and hence are well set back from the main excavation works in this area. Further comment on Lackagh Quarry site compound is discussed separately in the following Section.

Construction of the N84 Headford Road Junction and the cutting on the eastern side of Lackagh Quarry (Construction Section S12) will involve substantial earthworks for both cutting and embankment construction. There will be a large cutting into the eastern face of Lackagh Quarry within the eastern end of this Section which is located some 300m from the nearest noise sensitive locations. Construction of the N84 Headford Road Junction will involve extensive engineered fill works to cross the existing N84 Headford Road with an element of cutting required for slip roads. The closest noise sensitive locations are within 40 to 50m from these works and hence there is potential for construction noise levels to exceed daytime, evening and weekend construction noise criteria in the absence of noise mitigation measures.

Construction Section S13 between School Road to Galway Racecourse Tunnel will involve a large number of major earthworks including a large cutting east of School Road and a grade separated junction at the N83 Tuam Road involving engineered embankments to cross the existing N83 Tuam Road. Moving east, the mainline will cut into a hill as far as the portal of the proposed Galway Racecourse Tunnel, thus requiring extensive excavation in this area. Drill and blast will be required for the main excavated sections in these areas. The closest noise sensitive locations to the excavation works west of School Road are between 30 and 50m thus the construction noise criteria for day, evening and weekend periods are likely to be exceeded in the absence of mitigation measures during specific excavation works. Further discussion on mitigation measures are discussed in **Section 17.6.1**.

Construction Section S14 involves the construction of the Galway Racecourse Tunnel using cut and cover techniques. Excavation will likely involve drill and blast to remove the shallow rock head in this area. The works will be scheduled in consultation with Galway Racecourse to minimise the disruption to the commercial practice of the business throughout the year. The construction works will be phased and will cease for the racing period. The closest noise sensitive locations to the tunnel works are typically 90 to 100m at commercial premises to the north and residential properties to the southeast. During short term periods of high noise activities (drill and blast, rock crushing etc.) there is potential for the construction noise criteria to be exceeded in the absence of mitigation. During the main construction of the tunnel structure and ancillary elements, construction noise levels will be further reduced.

The construction Section S15 between Galway Racecourse Tunnel and Coolagh Junction will involve excavation works to the east of the tunnel portal and the connection with the existing N6/M6 at Coolagh. Drill and blast excavation is possible at these locations due to the presence of shallow rock. There is a large amount of engineering fill required in this section due to the proposed overbridges and raised junction at Coolagh which will require a large amount of earthworks mobile plant and machinery. The closest noise sensitive locations to large excavation works are at distances of approximately 90m. There is potential for exceedance of the construction noise criteria during day, evening or weekend periods in the absence of noise mitigation at these properties. The closest noise sensitive locations to the Coolagh Junction are between 80 and 100m. It is possible to work within the construction noise criteria at these distances from the main engineering fill works, depending on the activities involved.

Structures

Construction of various bridge structures over and under existing roads, the Menlo Viaduct, River Corrib Bridge Crossing, Lackagh and Galway Racecourse Tunnel Structures will involve standard construction techniques which will likely involve piling (type and method dependent on ground conditions), engineered fill structures, lifting equipment etc. Daytime construction noise limits can typically be complied with at distances of 50m and beyond from these works.

Temporary night-time closure of existing roads will be required where overbridges are to be constructed at locations such as the Rahoon Road, Letteragh Road, N59 Moycullen Road, Menlo Castle Bóthrín, Bóthar Nua, An Seanbóthar, N84 Headford Road, N83 Tuam Road, Briarhill Business Park Road and R339 Monivea Road. This is required to avoid road closure during day time periods to facilitate lifting beams into place and other key works. Heavy or noisy construction activities will be avoided outside normal hours and the amount of work outside normal hours will be strictly controlled.

Noise levels associated with night-time works will tyically involve lifting equipment for beam construction. There is potential for the use of generators to power temporary lighting and other small items of mobile plant. Noise levels will be strictly controlled during these phases to ensure noisy items of plant are sited away from noise sensitive properties (e.g. generators), are enclosed or screened. Specific noise limits for night-time works will be set taking into account the pre-existing noise environment as per **Table 17.2**. These limits are site specific, hence will be fully reviewed prior to commencement of any night works and specific noise control measures put in palce. Best practice control meaures that will form part of the noise mitigation are included in **Section 17.6.1**.

Site Compounds

There are twelve sites identified as potential site compounds across the proposed road development. The siting of compounds has been chosen based on proximity to major works, proximity to residential properties and other environmental constraints. The site compounds are listed in **Table 17.10** with approximate distance to nearest noise sensitive locations and general comments on potential noise impacts included.

Table 17.10: Site Compound Potential Noise Impacts

Site No.	Location	Main Construction Activities	Closest Noise Sensitive Locations (m)	Potential Impacts
SC 00/01	R336 Baile Nua	Western tie-in for proposed road development	10	Potential exceedance of construction noise criteria to east of compound. Boundary screening, working hours, site layout planning to be undertaken prior to commencement of works
SC 04/01	Aille	Aille Cutting, Rock Crushing Plant	320	No significant impacts expected due to distances to NSL's. Assessment of rock crushing noise impacts required prior to commencement
SC 05/01	Ballymoneen	Aille Cutting, Letteragh and Rahoon Road Overbridge	50 – 100	Potential exceedance of construction noise criteria to southeast of compound, depending on siting of on-site activities. Boundary screening to south/ south east and site layout planning will be undertaken
SC 07/01	Letteragh	Major cut at Letteragh for GSJ and River Corrib Bridge (western section) Rock Crushing & Regrading Plant	400	Impacts can be well controlled through siting high noise activities away from noise sensitive boundaries
SC 08/01	Dangan (Aughnacurra)	River Corrib Bridge (western section). Used for storage only.	10 – 20	Storage only. No significant activities on site. No significant impacts expected
SC 09/01	Menlough (East of River Corrib)	River Corrib Bridge (eastern section) & Menlough Viaduct	400	No significant impacts expected due to distances to noise sensitive locations
SC 11/01	Lackagh Quarry	Lackagh Tunnel and potential for concrete batching plant, crushing and regrading of material.	100 – 200	Impacts can be well controlled through siting high noise activities away from noise sensitive boundaries, site orientation and use of quarry face for noise screening

Site No.	Location	Main Construction Activities	Closest Noise Sensitive Locations (m)	Potential Impacts
SC 14/01	Twomileditch (N83 Tuam Road Junction)	N83 Tuam Road Junction and Parkmore Link Road - Rock Crushing Plant	40 – 50	Potential exceedance of construction noise criteria at closet boundaries. Boundary screening to west and site layout planning will be undertaken
SC 14/02	Twomileditch (N83 Tuam Road Junction)	N83 Tuam Road Junction and Parkmore Link Road	200	No significant impacts. Boundary screening and site layout where necessary following assessment prior to commencement
SC 14/03	Twomileditch (N83 Tuam Road Junction)	N83 Tuam Road Junction and Parkmore Link Road	250	No significant impacts. Boundary screening and site layout where necessary following assessment prior to commencement
SC 14/04	Galway Racecourse Tunnel Western Portal	Galway Racecourse Tunnel (western section)	240	No significant impacts. Boundary screening and site layout where necessary following assessment prior to commencement
SC 15/01	Coolagh/Briarhill	Galway Racecourse Tunnel (eastern section)	30	Potential exceedance of construction noise criteria at closet boundaries. Boundary screening to north and east and siting of noisy activities away from noise sensitive boundaries will be undertaken
SC 16/01	Coolagh	Coolagh Junction	90	Potential exceedance of construction noise criteria at closet boundaries Boundary screening to north and east and site layout where necessary following assessment prior to commencement

The site compounds across the site are largely set back from noise sensitive properties and the noise emissions from these areas can be largely controlled through the use of boundary screening and site layout planning, as required. The largest site compound will be located at Lackagh Quarry which will be in use for the full extent of the construction of the proposed road development. This compound will be the main portal for the Lackagh Tunnel and will likely include a concrete batching plant, mobile rock crushing and rock grading equipment. All of the above have the potential to generate high levels of noise, however, given the large extent of the compound (9ha approximately), there is ample opportunity to sufficiently locate activities with high noise levels away from noise sensitive boundaries. In addition, the existing quarry profile will provide substantial screening to noise sensitive properties beyond.

Other site compounds where rock crushing activities are likely are well set back from noise sensitive locations and noise levels from this activity is not expected to generate noise levels in exceedance of the construction noise criteria. There is potential for rock crushing plant to be positioned within Site Compound SC 14/01 at the N83 Tuam Road Junction where noise sensitive properties are at distances of approximately 40m across the N83 Tuam Road. The location of rock processing equipment can be sited at distances further into the compound to reduce noise emission from this activity.

Overall, the potential impacts during the construction phase will be moderate to very significant and short term in the absence of noise mitigation. A range of control measures will be required at specific working areas to suitably reduce noise impacts at noise sensitive locations.

Emergency Work

Emergency work may include the replacement of warning lights, signs and other safety items on public roads, the repair of damaged fences, repair of water supplies and other services which have been interrupted, repair to any damaged temporary works and all repairs associated with working on public roads.

17.5.3.2 Construction Traffic

In addition to direct impacts from the construction works including site compounds, there is also the potential for noise impacts from construction traffic along public roads.

A detailed analysis of construction traffic volumes has been conducted to determine the expected lorry movements required to transport the materials extracted and delivered to site. A total of 16 public roads has been identified as required haul routes where construction traffic will be permitted to travel along. Whilst the overall construction period is forecast as three years, construction traffic movements are split over a 12 month period along haul roads accessing specific work zones and a two-year period for national and regional roads serving multiple work zones to allow for a robust assessment to be made.

Traffic volumes for the base scenario are based on the 2024 Do Minimum flows projected along the local road network. These are AADT flows with percentage HGV’s. The additional HGV and LGV flows per day associated with construction traffic along each road including construction staff vehicles, deliveries and earthworks material haulage are added to the base traffic volumes. The estimated construction traffic volumes incorporate a series of worst case assumptions including concentrated construction periods at working areas and assumes that no delivery of materials will occur along the corridor of the proposed road development which is highly worst case. In reality the proposed road development will be constructed in phases and the corridor of the proposed road development will be used for a large bulk of construction delivery vehicles along its route.

In order to determine the potential noise impacts associated with additional construction traffic on the identified haul routes, a comparison between traffic noise levels during for the base (Do Minimum) scenario and the Do Something (base plus construction) scenario were determined.

Noise levels associated with passing event such as road traffic may be expressed in terms of its Sound Exposure Level (L_{AX}). The Sound Exposure Level can be used to calculate the contribution of an event or series of events to the overall noise level in a given period using the following formulae:

$L_{Aeq,T} = L_{AX} + 10\log10(N) - 10\log10(T)$ dB

where:
$L_{Aeq,T}$ is the equivalent continuous sound level over the time period T (in seconds)
L_{AX} is the "A-weighted" Sound Exposure Level of the event considered (dB)
N is the number of events over the course of time period T

The mean value of Sound Exposure Level for truck moving at low to moderate speeds is in the order of 82dB L_{AX} at a distance of 10 metres from the vehicle. The mean value of Sound Exposure Level for car or light good vehicle passing at low to moderate speeds is in the order of 68dB L_{AX} at a distance of 10 metres from the vehicle.

Noise levels associated with additional construction traffic volumes are calculated over a 12hr period, relating to the typical construction working day (i.e. 07:00 to 19:00hrs). The combined value represents the total noise level over a daily (24hr) period.

Table 17.11 presents a summary of the construction traffic noise assessment. Traffic noise levels at a distance of 10m from the haul roads is calculated for the base (Do-Minimum) scenario and the Do-Something (base plus construction) scenario. The increase in noise levels between both scenarios is also presented.

Reference to **Table 17.11** overleaf confirms the increase in noise level along the majority of the haul routes is negligible (<1dB) due to the existing volume of traffic along these roads and the relatively low additional HGV and LGV traffic per day forecast. The greatest increase in noise levels is calculated along the Bearna to Moycullen Road (L1321) in Zone 1, the Cappagh Road in Zone 2 and along Bóthar Nua in Zone 4.

Along the Bearna to Moycullen Road (L1321), existing traffic volumes are moderate with an associated low number of HGV's. Noise levels are calculated to increase by the order of 3dB over a concentrated worst case 12-month period assuming an additional 20 HGV and 374 LGV movements per day along this road. Reference to **Table 17.5** (classifications of Magnitude of Noise Impacts in the Short Term) defines an increase of this magnitude to be 'moderate'. Whilst a perceptible change in noise level is calculated, the overall noise level along this road is of low to moderate level, calculated at 56dB $L_{Aeq,T}$ at 10m from the road edge. Considering the above, the overall impact is deemed to be moderate, short-term.

Along the Cappagh Road, existing traffic volumes are low with an associated low number of HGV's. Noise levels are calculated to increase by the order of 8dB over a concentrated worst case 12-month period assuming an additional 29 HGV and 370 LGV movements per day along this road. Reference to **Table 17.5** (classifications of Magnitude of Noise Impacts in the Short Term) defines an increase of this magnitude to be 'major'. Whilst a perceptible change in noise level is calculated, the overall noise level along this road will remain low to moderate, at

55dB $L_{Aeq, T}$ at 10m from the road edge. Considering the above, the overall impact is deemed to be moderate, short-term.

Along Bóthar Nua, existing traffic volumes are moderate and baseline noise levels are calculated as 55dB $L_{Aeq, T}$ at 10m from the existing road edge. Noise levels are calculated to increase by the order of 7dB over a concentrated worst case 12-month period assuming an additional 154 HGV and 177 LGV movements per day along this road. Reference to **Table 17.5** defines an increase of this magnitude to be 'major'. Whilst a perceptible change in noise level is calculated, the overall noise level along this road are calculated as 62dB $L_{Aeq,T}$ at 10m from the existing road edge. Considering the above, the overall impact is deemed to be major, short-term.

Table 17.11: Construction Traffic Noise Assessment

Section	Road Link	Do Minimum		Do Something (Construction)		Calculated Change in Noise Levels, dB
		Total Vehicles (AADT)	Do Minimum Noise Level at 10m, dB	Additional Construction (AADT)	Cumulative Noise Level at 10m, dB	
Zone 1	R336	14,550	63	394	64	+0.4
Zone 1	Bearna to Moycullen Road - L1321Road	1,841	52	394	56	+3.4
Zone 2	Cappagh Road	494	47	399	55	+8.4
Zone 2	Seamus Quirke Road	13,789	64	396	65	+0.4
Zone 2	Kingston Road. Kingston	11,278	63	396	63	+0.5
Zone 3	N59 at Hazel Park	6,343	59	119	60	+0.8
Zone 3	N59 at Chestnut Lane	16,596	64	119	64	+0.3
Summary of West	Quincentenary Bridge	33,491	69	486	69	+0.2
Zone 4	Bóthar Nua	3,344	55	330	62	+6.8
Zone 5	N84 Headford Road at Ballinfoyle	12,819	64	174	65	+0.4
Zone 5	N83 Tuam Road at City North Business Park	17,250	66	174	66	+0.3

Section	Road Link	Do Minimum		Do Something (Construction)		Calculated Change in Noise Levels, dB
		Total Vehicles (AADT)	Do Minimum Noise Level at 10m, dB	Additional Construction (AADT)	Cumulative Noise Level at 10m, dB	
Zone 5	N6 Bóthar na dTreabh between N83 Tuam Road Junction and Morris Junction	25,721	68	825	68	+0.8
Zone 5	N6 Bóthar na dTreabh between N84 Headford Road Junction and N83 Tuam Road Junction	20,019	66	810	67	+1.0
Zone 6	Parkmore Link Road at Business Park Junction 2	3,567	60	264	62	+2.0
Zone 6	N6 Bóthar na dTreabh between Morris Junction and Lynch Junction	24,446	68	957	69	+0.8
Zone 7	N6 Bóthar na dTreabh at Ardaun	19,223	68	1,025	69	+0.9

17.5.3.3 Vibration

The potential for elevated levels of vibration at sensitive locations during construction is typically associated with excavation works, rock-breaking and blasting operations. Depending on the method and equipment used, there is potential for some vibration relating to piling operations, demolition works and lorry movements on uneven road surfaces. The more significant of these relates to vibration from excavation and rock-breaking operations.

In terms of piling, low vibration methods involving bored or augured piles will be selected over and above percussive type piling, where ground conditions permit. This piling method significantly minimises the levels of both noise and vibration generated as it is a non-percussive piling technique.

For the purposes of this assessment, however, vibration levels associated with driven piles are assessed in order to determine potential worst case impacts. British Standard BS 5228 *2 :2009+A1:2014: Vibration*, includes measured magnitude of vibration associated with different piling types. **Table 17.12** reproduces those associated with steel sheet piling.

Table 17.12: Vibration Magnitudes associated with Sheet Steel Piling

Soil Conditions	Pile Dimensions	Distance, m	PPV, mm/s
Very soft to soft (0 – 10m), soft to medium clay (10 – 20m)	U-shaped LX 16 sheet piles	4.8 – 24	4.3 – 0.5
(not provided)	U-shaped piles	7.1	0.3 – 0.7
Made ground 0 – 3m, loose and very dense sand and silt 3 – 17m, firm to stiff clay 17 – 25m	244mm diameter driven tubular steel piles	5 – 20	13.9 – 4.3
Made ground 0 – 3m, loose and very dense sand and silt 3 – 17m, firm to stiff clay 17 – 25m	275mm driven square piles	5 – 20	11.4 – 4.3

The vibration magnitudes outlined in **Table 17.12** indicate that at distances beyond 20m, vibration magnitudes are significantly reduced to well below those associated with any form of cosmetic damage to buildings.

During rock breaking, there is also potential for vibration to be generated through the ground. Empirical data for this activity is not provided in the BS 5228-*2:2009+A1:2014* standard, however the likely levels of vibration from this activity is expected to be significantly below the vibration criteria for building damage on experience from other sites. AWN Consulting have previously conducted vibration measurements under controlled conditions, during trial construction works, on a sample site where concrete slab breaking was carried out. The trial construction works consisted of the use of the following plant and equipment when measured at various distances:

- 3 tonne hydraulic breaker on small CAT tracked excavator
- 6 tonne hydraulic breaker on large Liebherr tracked excavator

Vibration measurements were conducted during various staged activities and at various distances.

Peak vibration levels during staged activities using the 3 Tonne Breaker ranged from 0.48 to 0.25 PPV (mm/s) at distances of 10 to 50m respectively from the breaking activities. Using a 6 Tonne Breaker, measured vibration levels ranged between 1.49 to 0.24 PPV (mm/s) at distances of 10 to 50m respectively.

Whilst these measurements relate to a solid concrete slab, the range of values recorded provides some context in relation typical ranges of vibration generated by construction breaking activity.

Demolition of existing structures will involve careful deconstruction using controlled techniques. There may be a requirement for breaking ground as part of specific demolition procedures, depending on the structure. Vibration levels associated with this activity will be of similar or lower magnitude to rock breaking discussed above.

Referring to the vibration magnitudes above, vibration impacts due to ongoing construction works will be not significant and short term.

Notwithstanding the above, any construction activities undertaken on the site will be required to operate below the recommended vibration criteria set out in **Table 17.3**.

17.5.3.4 Blasting

Ground investigations have indicated that blasting will be required at a number of locations along the route of the proposed road development, in proximity to access roads, stream diversions and attenuation ponds, ref **Figures 7.3.1** and **7.3.2**. The extent of blasting will depend on the rock type and depth in the area and the depth of the cutting involved. For the majority of identified locations, a relatively shallow blast depth is required. There are a number of locations along the route of the proposed road development where a cut depth of greater than 10m will be required as part of the construction of the proposed road development.

Whilst drill and blast methods generate intermittent high noise levels when taking place, the time period over which impacts are experienced are significantly shorter compared to other extraction methods. For the proposed road development where a significant portion of hard rock is required to be excavated, the use of drill and blast will enable extraction works to be undertaken at a significantly faster rate compared to traditional rock breaking techniques.

Blasting impacts relate to both ground vibration and air overpressure, the magnitude of which depends on a variety of factors.

Air Overpressure (AOP)

Air overpressure is energy transmitted from the blast site within the atmosphere in the form of pressure waves. As such a wave passes a given position, the pressure of the air at this point rises very rapidly to a value above the ambient pressure, and then falls more slowly to a value below, before returning to the ambient value after a series of oscillations. The maximum excess pressure in this wave is known as the peak air overpressure. This value is typically measured in terms of dB (L_{in}).

These pressure waves will consist of energy over a wide range of frequencies, some of which are audible and known as sound waves or noise, but most of the energy is inaudible at frequencies of less than 20Hz which is not heard by the human ear but is sensed as pressure.

The main sources of air overpressure from blasting relate to blast design and set up (e.g. detonating cord, stemming release and gas venting) and physical properties of the site (movement of rock and reflection of stress waves). The intensity of air overpressure levels at a receiver location is highly dependent on meteorological conditions which affect ambient air pressure including temperature, cloud cover, humidity, wind speed and direction etc. Due to the large variability in these conditions, it is not possible to reliably calculate AOP. The control of its intensity is therefore undertaken at source through careful blast design.

It is important to note that routine open-pit blasting operations regularly generate air overpressures up to a magnitude of 120dB (Lin), with levels in excess of 125dB (Lin) being relatively rare. Damage levels are rarely approached let alone exceeded. BS 5228-2 notes that there is no known evidence of structural damage to structures from excessive air overpressure levels from quarry blasting in the UK.

Ground Vibration

The level of vibration at a receiver location from a blast depends predominately on the distance from the blast, the maximum instantaneous charge (MIC), sequencing of charges and ground conditions between the blast area and the receiver location. Whilst it is possible to undertake indicative predictive calculations for ground vibrations from a blast site using information on the MIC, distance and ground factors, the most accurate methodology for determining vibration levels is through controlled trial blasts at specific sites and undertaking scaled distance regression analysis to determine maximum charge values in order to comply with set criteria. This is therefore undertaken by experienced contractors as part of the blast design (refer to **Chapter 9, Soils and Geology**).

In the case of the proposed road development, blast events will be clearly perceptible at the nearest sensitive receptors due to ground vibration and air overpressure levels, however the duration of the effects are intermittent. The overall impacts are therefore considered to be significant, momentary and localised. The closest sensitive properties to the identified likely blast sites are at distances of 30 to 50m. It is expected that these potential impacts can be appropriately mitigated through the implementation of best practice blasting control measures which are outlined in **Section 17.6.1**. Specific assessment of potential impacts of blasting on birds and other sensitive species are included in **Chapter 8, Biodiversity**.

17.5.4 Potential Operational Impacts

17.5.4.1 Operational Noise Levels

Traffic noise levels have been calculated at the 299 receiver locations along the length of the proposed road development in accordance with the methodologies outlined in **Section 17.2.5**.

The calculated noise levels in **Table 17.13** are presented for the Opening Year (2024) and Design Year (2039) of the proposed road development and compares the calculated results against the three TII conditions (referenced in **Section 17.2.2.2**) for noise mitigation.

When considering the requirement for noise mitigation under Condition C, traffic noise levels must be attributed to the physical proposed road development under consideration in order for noise mitigation to be provided. In certain instances, traffic flows along the local road network are higher during the Do-Something scenario compared to the Do-Nothing scenario due to traffic volumes along these road links. In these instances, Condition C is not triggered and hence noise mitigation is not included as part of this proposed road development.

The calculated "Do Minimum" noise levels presented in Table 17.13 relate to traffic noise levels associated with modelled roads only. These are presented predominately to assess the requirement for noise mitigation against Condition b, particularly for locations along existing roads where traffic noise levels exceed 60dB L_{den} in the absence of the proposed road development.

The modelled calculated noise level at each assessment location is included within **Table 17.13**.

Table 17.13: Calculated Traffic Noise Levels

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
1	R336 West of Bearna West Roundabout	61	62	Yes	No	No	No	62	63	Yes	No	No	No
2	R336 West of Bearna West Roundabout	58	59	No	No	No	No	59	59	No	No	No	No
3	Na Foraí Maola Thoir	39	46	No	Yes	Yes	No	39	47	No	Yes	Yes	No
4	Na Foraí Maola Thoir	38	49	No	Yes	Yes	No	39	50	No	Yes	Yes	No
5	R336 West of Bearna West Roundabout	62	62	Yes	No	No	No	62	63	Yes	No	No	No
6	R336 West of Bearna West Roundabout	62	63	Yes	No	No	No	63	64	Yes	No	No	No
7	R336 West of Bearna West Roundabout	57	60	No	Yes	Yes	No	58	61	Yes	Yes	Yes	Yes
8	R336 East of Bearna West Roundabout	58	61	Yes	Yes	Yes	Yes	59	62	Yes	Yes	Yes	Yes
9	Na Foraí Maola Thoir	43	56	No	Yes	Yes	No	43	57	No	Yes	Yes	No
10	Na Foraí Maola Thoir	39	57	No	Yes	Yes	No	39	57	No	Yes	Yes	No
11	Na Foraí Maola Thoir	44	55	No	Yes	Yes	No	45	55	No	Yes	Yes	No

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
12	R336 East of Bearna West Roundabout	66	66	Yes	No	No	No	67	67	Yes	No	No	No
13	Na Foraí Maola Thoir	35	62	Yes	Yes	Yes	Yes	36	62	Yes	Yes	Yes	Yes
14	Na Foraí Maola Thoir	44	52	No	Yes	Yes	No	45	53	No	Yes	Yes	No
15	Na Foraí Maola Thoir	40	52	No	Yes	Yes	No	40	53	No	Yes	Yes	No
16	Na Foraí Maola Thiar	36	54	No	Yes	Yes	No	36	55	No	Yes	Yes	No
17	Na Foraí Maola Thoir	52	54	No	Yes	Yes	No	53	55	No	Yes	Yes	No
18	Na Foraí Maola Thoir	37	53	No	Yes	Yes	No	37	54	No	Yes	Yes	No
19	Na Foraí Maola Thoir (to be demolished)	37	63	Yes	Yes	Yes	No	38	64	Yes	Yes	Yes	No
20	Na Foraí Maola Thoir	46	51	No	Yes	Yes	No	46	52	No	Yes	Yes	No
21	Na Foraí Maola Thoir	44	50	No	Yes	Yes	No	44	51	No	Yes	Yes	No
22	Na Foraí Maola Thoir	35	55	No	Yes	Yes	No	36	56	No	Yes	Yes	No
23	Na Foraí Maola Thiar	37	58	No	Yes	Yes	No	37	59	No	Yes	Yes	No
24	Na Foraí Maola Thiar	39	53	No	Yes	Yes	No	39	54	No	Yes	Yes	No
25	Foraí Maola Road	47	47	No	No	No	No	47	47	No	No	No	No
26	Foraí Maola Road	44	55	No	Yes	Yes	No	44	56	No	Yes	Yes	No

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
27	Na Foraí Maola Thiar (to be acquired)	44	63	Yes	Yes	Yes	Yes	44	64	Yes	Yes	Yes	Yes
28	Foraí Maola Road	43	50	No	Yes	Yes	No	43	50	No	Yes	Yes	No
29	Foraí Maola Road	41	56	No	Yes	Yes	No	41	57	No	Yes	Yes	No
30	R336 East of Bearna West Roundabout	65	65	Yes	No	No	No	65	66	Yes	No	No	No
31	Na Foraí Maola Thoir	34	54	No	Yes	Yes	No	34	55	No	Yes	Yes	No
32a	Na Foraí Maola Thoir	48	57	No	Yes	Yes	No	48	58	No	Yes	Yes	No
32b	Na Foraí Maola Thoir	34	59	No	Yes	Yes	No	35	60	No	Yes	Yes	No
33	Na Foraí Maola Thoir	46	58	No	Yes	Yes	No	46	59	No	Yes	Yes	No
34	Na Foraí Maola Thoir	42	54	No	Yes	Yes	No	42	55	No	Yes	Yes	No
35	Troscaigh Road	48	55	No	Yes	Yes	No	48	55	No	Yes	Yes	No
36	Troscaigh Road (to be acquired)	48	58	No	Yes	Yes	No	48	59	No	Yes	Yes	No
37	Troscaigh Road	45	59	No	Yes	Yes	No	45	59	No	Yes	Yes	No
38	Troscaigh Road	38	56	No	Yes	Yes	No	38	57	No	Yes	Yes	No
39	Troscaigh Road	43	58	No	Yes	Yes	No	43	58	No	Yes	Yes	No
40	Troscaigh Road	38	62	Yes	Yes	Yes	Yes	38	62	Yes	Yes	Yes	Yes

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
41	Troscaigh Road	47	52	No	Yes	Yes	No	47	52	No	Yes	Yes	No
42	Troscaigh Thiar	31	53	No	Yes	Yes	No	31	54	No	Yes	Yes	No
43	Troscaigh- Ann Gibbons Road	33	51	No	Yes	Yes	No	33	52	No	Yes	Yes	No
44	Troscaigh- Ann Gibbons Road	31	55	No	Yes	Yes	No	31	56	No	Yes	Yes	No
45	Troscaigh- Ann Gibbons Road	32	48	No	Yes	Yes	No	32	48	No	Yes	Yes	No
46	Troscaigh- Ann Gibbons Road	34	61	Yes	Yes	Yes	Yes	34	61	Yes	Yes	Yes	Yes
47	Troscaigh Thoir	40	52	No	Yes	Yes	No	41	52	No	Yes	Yes	No
48	Troscaigh Thoir - L1321 North	47	58	No	Yes	Yes	No	48	58	No	Yes	Yes	No
49	Troscaigh Thoir - L1321 North	50	58	No	Yes	Yes	No	50	59	No	Yes	Yes	No
50	Troscaigh Thoir - L1321 North	46	56	No	Yes	Yes	No	47	56	No	Yes	Yes	No
51	Troscaigh Thoir - L1321 South	50	57	No	Yes	No	No	51	58	No	Yes	No	No

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
52	An Chloch Scoilte	35	52	No	Yes	Yes	No	35	53	No	Yes	Yes	No
53	An Chloch Scoilte	37	56	No	Yes	Yes	No	37	57	No	Yes	Yes	No
54a	An Chloch Scoilte	37	47	No	Yes	Yes	No	37	48	No	Yes	Yes	No
54b	An Chloch Scoilte	33	51	No	Yes	Yes	No	33	52	No	Yes	Yes	No
55	An Chloch Scoilte	42	52	No	Yes	Yes	No	42	53	No	Yes	Yes	No
56	An Chloch Scoilte (to be acquired)	47	57	No	Yes	Yes	No	47	58	No	Yes	Yes	No
57	An Chloch Scoilte - Aille Road L5384	45	50	No	Yes	Yes	No	45	51	No	Yes	Yes	No
58	An Chloch Scoilte- Aille Road L5384	45	52	No	Yes	Yes	No	45	52	No	Yes	Yes	No
59	An Chloch Scoilte- Aille Road L5384 (to be acquired)	39	52	No	Yes	Yes	No	39	52	No	Yes	Yes	No
60	Ballard East	45	56	No	Yes	Yes	No	45	56	No	Yes	Yes	No
61	An Chloch Scoilte - Aille Road L5384	40	56	No	Yes	Yes	No	40	56	No	Yes	Yes	No
62	Cappagh Road North	46	54	No	Yes	Yes	No	47	54	No	Yes	Yes	No
63a	Cappagh Road North	49	65	Yes	Yes	Yes	Yes	49	66	Yes	Yes	Yes	Yes

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
63b	Cappagh Road North	49	62	Yes	Yes	Yes	Yes	49	63	Yes	Yes	Yes	Yes
64a	Cappagh Road North	46	57	No	Yes	Yes	No	47	58	No	Yes	Yes	No
64b	Cappagh Road North	36	53	No	Yes	Yes	No	36	53	No	Yes	Yes	No
65a	Cappagh Road North	47	60	No	Yes	Yes	No	48	61	Yes	Yes	Yes	Yes
65b	Cappagh Road North	39	60	No	Yes	Yes	No	39	61	Yes	Yes	Yes	Yes
66a	Cappagh Road South	44	63	Yes	Yes	Yes	Yes	45	63	Yes	Yes	Yes	Yes
66b	Cappagh Road South	48	64	Yes	Yes	Yes	Yes	48	64	Yes	Yes	Yes	Yes
67a	Cappagh Road South	45	60	No	Yes	Yes	No	45	60	No	Yes	Yes	No
67b	Cappagh Road South	49	60	No	Yes	Yes	No	49	61	Yes	Yes	Yes	Yes
68	Ballyburke	39	53	No	Yes	Yes	No	39	54	No	Yes	Yes	No
69	Ballyburke	39	55	No	Yes	Yes	No	39	56	No	Yes	Yes	No
70	Ballyburke	39	57	No	Yes	Yes	No	39	58	No	Yes	Yes	No
71	Ballyburke	40	59	No	Yes	Yes	No	40	59	No	Yes	Yes	No
72	Ballymoneen Road South	36	57	No	Yes	Yes	No	36	58	No	Yes	Yes	No
73	Ballymoneen Road South	40	55	No	Yes	Yes	No	40	56	No	Yes	Yes	No
74a	Ballymoneen Road South	50	66	Yes	Yes	Yes	Yes	51	67	Yes	Yes	Yes	Yes
74b	Ballymoneen Road South	35	68	Yes	Yes	Yes	Yes	35	68	Yes	Yes	Yes	Yes

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
75a	Ballymoneen Road South	52	63	Yes	Yes	Yes	Yes	52	64	Yes	Yes	Yes	Yes
75b	Ballymoneen Road South	36	56	No	Yes	Yes	No	36	57	No	Yes	Yes	No
76	Ballymoneen Road North	51	61	Yes	Yes	Yes	Yes	51	62	Yes	Yes	Yes	Yes
77	Ballymoneen Road South	53	60	No	Yes	No	No	53	61	Yes	Yes	No	No
78	Ballymoneen Road South	52	60	No	Yes	No	No	52	61	Yes	Yes	No	No
79	Ballymoneen Road North	53	62	Yes	Yes	Yes	Yes	53	63	Yes	Yes	Yes	Yes
80a	Ballymoneen Road North	53	64	Yes	Yes	Yes	Yes	53	64	Yes	Yes	Yes	Yes
80b	Ballymoneen Road North	47	65	Yes	Yes	Yes	Yes	47	65	Yes	Yes	Yes	Yes
81	Ballymoneen Road South	42	58	No	Yes	Yes	No	42	58	No	Yes	Yes	No
82	Ballymoneen	55	51	No	No	Yes	No	55	52	No	No	Yes	No
83	Ballymoneen Road	54	61	Yes	Yes	No	No	54	62	Yes	Yes	No	No
84	Ballymoneen	55	53	No	No	Yes	No	55	54	No	No	Yes	No
85	Árd na Gaoithe - Ballymoneen	38	59	No	Yes	Yes	No	38	59	No	Yes	Yes	No
86	Árd na Gaoithe - Ballymoneen	39	62	Yes	Yes	Yes	Yes	39	63	Yes	Yes	Yes	Yes
87	Árd na Gaoithe - Ballymoneen	36	50	No	Yes	Yes	No	36	50	No	Yes	Yes	No

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
88	Árd na Gaoithe - Ballymoneen	40	61	Yes	Yes	Yes	Yes	40	61	Yes	Yes	Yes	Yes
89a	Rahoon Road	51	51	No	No	Yes	No	51	52	No	No	Yes	No
89b	Rahoon Road	50	59	No	Yes	Yes	No	50	59	No	Yes	Yes	No
90	Rahoon Road	41	59	No	Yes	Yes	No	41	60	No	Yes	Yes	No
91a	Rahoon Road	51	57	No	Yes	Yes	No	51	58	No	Yes	Yes	No
91b	Rahoon Road	48	58	No	Yes	Yes	No	48	58	No	Yes	Yes	No
92	Árd na Gaoithe - Ballymoneen	39	58	No	Yes	Yes	No	40	59	No	Yes	Yes	No
93	Clybaun Road South	42	58	No	Yes	Yes	No	42	58	No	Yes	Yes	No
94	Clybaun Road South	43	59	No	Yes	Yes	No	44	60	No	Yes	Yes	No
95	Clybaun Road North	42	61	Yes	Yes	Yes	Yes	42	61	Yes	Yes	Yes	Yes
96	Clybaun Road North	45	63	Yes	Yes	Yes	Yes	45	63	Yes	Yes	Yes	Yes
97	Clybaun Road North	37	55	No	Yes	Yes	No	37	55	No	Yes	Yes	No
98	Clybaun Road North	38	56	No	Yes	Yes	No	38	57	No	Yes	Yes	No
99	Rahoon Road	46	56	No	Yes	Yes	No	46	56	No	Yes	Yes	No
100	Rahoon Road	56	59	No	Yes	Yes	No	56	60	No	Yes	Yes	No

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
101	Rahoon Road	47	56	No	Yes	Yes	No	47	56	No	Yes	Yes	No
102	Rahoon Road	52	55	No	Yes	Yes	No	52	55	No	Yes	Yes	No
103	Between Rahoon & Letteragh Road	39	55	No	Yes	Yes	No	39	56	No	Yes	Yes	No
104	Between Rahoon & Letteragh Road	42	51	No	Yes	Yes	No	42	51	No	Yes	Yes	No
105	Rahoon Road	59	59	No	No	No	No	59	60	No	Yes	No	No
106	Between Rahoon & Letteragh Road	36	63	Yes	Yes	Yes	Yes	37	64	Yes	Yes	Yes	Yes
107	Letteragh Road North	43	64	Yes	Yes	Yes	Yes	46	65	Yes	Yes	Yes	Yes
108	Letteragh Road North	41	61	Yes	Yes	Yes	Yes	44	62	Yes	Yes	Yes	Yes
109	Letteragh Road South	42	61	Yes	Yes	Yes	Yes	44	62	Yes	Yes	Yes	Yes
110	Letteragh Road South	42	62	Yes	Yes	Yes	Yes	44	63	Yes	Yes	Yes	Yes
111	N59 Moycullen Road (Parknagapple)	63	63	Yes	No	No	No	63	63	Yes	No	No	No
112	N59 Link Road/ Bushypark	46	54	No	Yes	Yes	No	47	55	No	Yes	Yes	No
113	Letteragh Road South	45	59	No	Yes	Yes	No	47	60	No	Yes	Yes	No
114	Bun A Chonic	40	59	No	Yes	Yes	No	41	59	No	Yes	Yes	No

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
115	Rosán Glas - Letteragh	46	58	No	Yes	Yes	No	46	58	No	Yes	Yes	No
116	Knocknabrona (to be acquired)	36	62	Yes	Yes	Yes	Yes	37	63	Yes	Yes	Yes	Yes
117	Rosán Glas - Letteragh	58	58	No	No	No	No	58	59	No	No	No	No
118	Knocknabrona (to be acquired)	36	60	No	Yes	Yes	No	36	61	Yes	Yes	Yes	Yes
119	Bushypark/ N59 Moycullen Road	55	58	No	Yes	Yes	No	55	59	No	Yes	Yes	No
120a	Letteragh Road South	45	64	Yes	Yes	Yes	Yes	48	65	Yes	Yes	Yes	Yes
120b	Letteragh Road South	44	64	Yes	Yes	Yes	Yes	46	64	Yes	Yes	Yes	Yes
121	Bushypark/ N59 Moycullen Road	64	65	Yes	No	No	No	64	65	Yes	No	No	No
122	Bushypark/N59 Moycullen Road	59	59	No	No	No	No	59	59	No	No	No	No
123	Bushypark/ N59 Moycullen Road	65	65	Yes	No	No	No	66	66	Yes	No	No	No
124	Knocknabrona (Cloghscoltia)	36	58	No	Yes	Yes	No	37	59	No	Yes	Yes	No
125	Knocknabrona (Cloghscoltia)	37	58	No	Yes	Yes	No	38	59	No	Yes	Yes	No

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
126	N59 Link Rd /Radharc an Locha	49	52	No	Yes	Yes	No	49	52	No	Yes	Yes	No
127	St. James' Church N59 Moycullen Road	60	60	No	No	No	No	60	61	Yes	No	Yes	No
128	Letteragh Road South	46	63	Yes	Yes	No	No	49	65	Yes	Yes	No	No
129	Letteragh Road South	46	60	No	Yes	No	No	48	61	Yes	Yes	No	No
130	Letteragh Road South	41	59	No	Yes	No	No	44	60	No	Yes	No	No
131	N59 Moycullen Road	62	62	Yes	No	Yes	No	62	63	Yes	No	Yes	No
132	The Heath Knocknabrona	37	54	No	Yes	Yes	No	37	55	No	Yes	Yes	No
133	Knocknabrona	36	52	No	Yes	Yes	No	37	52	No	Yes	Yes	No
134	Barnacranny	40	61	Yes	Yes	Yes	Yes	40	62	Yes	Yes	Yes	Yes
135	The Heath	40	60	No	Yes	Yes	No	40	60	No	Yes	Yes	No
136	Barnacranny	50	62	Yes	Yes	Yes	Yes	50	63	Yes	Yes	Yes	Yes
137	Circular Road	36	51	No	Yes	Yes	No	37	52	No	Yes	Yes	No
138	The Heath	43	66	Yes	Yes	Yes	Yes	43	67	Yes	Yes	Yes	Yes
139	N59 Moycullen Road/ Ard na Locha	61	63	Yes	Yes	Yes	Yes	61	64	Yes	Yes	Yes	Yes
140	Barnacranny	49	68	Yes	Yes	Yes	Yes	49	69	Yes	Yes	Yes	Yes

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		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
141	N59 Moycullen Road/Chestnut Lane	63	63	Yes	No	Yes	No	63	63	Yes	No	Yes	No
142	N59 Moycullen Road/ Ard na Locha	50	65	Yes	Yes	Yes	Yes	50	66	Yes	Yes	Yes	Yes
143	The Heath_ Upper Dangan	43	59	No	Yes	Yes	No	44	60	No	Yes	Yes	No
144a	Árd an Locha (to be acquired)	54	66	Yes	Yes	Yes	Yes	54	66	Yes	Yes	Yes	Yes
144b	Árd an Locha (to be acquired)	57	63	Yes	Yes	Yes	Yes	58	64	Yes	Yes	Yes	Yes
145	The Heath	46	63	Yes	Yes	Yes	Yes	46	64	Yes	Yes	Yes	Yes
146a	Árd an Locha	45	66	Yes	Yes	Yes	Yes	46	67	Yes	Yes	Yes	Yes
146b	Árd an Locha	50	69	Yes	Yes	Yes	Yes	50	70	Yes	Yes	Yes	Yes
147a	Árd an Locha	59	66	Yes	Yes	Yes	Yes	60	67	Yes	Yes	Yes	Yes
147b	Árd an Locha/ N59 Moycullen Road	67	67	Yes	No	Yes	No	67	68	Yes	No	Yes	No
148a	N59 Moycullen Road/ Aughnacurra	62	64	Yes	Yes	Yes	Yes	62	65	Yes	Yes	Yes	Yes
148b	N59 Moycullen Road/ Aughnacurra	65	65	Yes	No	Yes	No	66	66	Yes	No	Yes	No
149	Circular Road Upper Dangan	47	61	Yes	Yes	Yes	Yes	48	62	Yes	Yes	Yes	Yes

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		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
150	St. James' National School Upper Dangan	48	63	Yes	Yes	Yes	Yes	48	64	Yes	Yes	Yes	Yes
151a	Upper Dangan /N59 Moycullen Road	60	67	Yes	Yes	Yes	Yes	60	68	Yes	Yes	Yes	Yes
151b	Upper Dangan /N59 Moycullen Road	57	67	Yes	Yes	Yes	Yes	58	68	Yes	Yes	Yes	Yes
152	Aughnacurra	49	60	No	Yes	Yes	No	49	61	Yes	Yes	Yes	Yes
153	Aughnacurra (to be acquired)	56	66	Yes	Yes	Yes	Yes	57	67	Yes	Yes	Yes	Yes
154	Aughnacurra	51	65	Yes	Yes	Yes	Yes	52	66	Yes	Yes	Yes	Yes
155	Upper Dangan/N59 Moycullen Road	61	65	Yes	Yes	Yes	Yes	62	66	Yes	Yes	Yes	Yes
156	Aughnacurra	45	64	Yes	Yes	Yes	Yes	45	65	Yes	Yes	Yes	Yes
157	N59 Moycullen Road	64	64	Yes	No	Yes	No	64	65	Yes	No	Yes	No
158	NUIG	49	67	Yes	Yes	Yes	Yes	50	68	Yes	Yes	Yes	Yes
159	N59 Moycullen Road	68	67	Yes	No	No	No	69	67	Yes	No	No	No
160	NUIG	46	65	Yes	Yes	Yes	Yes	46	66	Yes	Yes	Yes	Yes
161	N59 Moycullen Road	69	68	Yes	No	No	No	69	68	Yes	No	No	No
162	N59 Moycullen Road/NUIG	59	62	Yes	Yes	Yes	Yes	60	62	Yes	Yes	Yes	Yes

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		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
163	Dangan House	43	61	Yes	Yes	Yes	Yes	44	62	Yes	Yes	Yes	Yes
164	N59 Moycullen Road/Clifton Close	64	63	Yes	No	No	No	65	64	Yes	No	No	No
165	Menlo Castle	45	63	Yes	Yes	Yes	Yes	45	64	Yes	Yes	Yes	Yes
166	The Orchard, Menlo Park, Menlough	40	57	No	Yes	Yes	No	40	58	No	Yes	Yes	No
167	Menlough/ Bóthar Nua	42	60	No	Yes	Yes	No	42	61	Yes	Yes	Yes	Yes
168	Coolough Road	42	62	Yes	Yes	Yes	Yes	42	63	Yes	Yes	Yes	Yes
169	Menlough / Seanbóthar	45	59	No	Yes	Yes	No	45	60	No	Yes	Yes	No
170	Menlough / Seanbóthar	55	65	Yes	Yes	Yes	Yes	55	65	Yes	Yes	Yes	Yes
171	Coolough Rd	45	58	No	Yes	Yes	No	45	59	No	Yes	Yes	No
172	N84 Headford Road/ Ballinfoyle	64	66	Yes	Yes	No	No	65	66	Yes	No	No	No
173	Ballindooley Boithrin / N84 Junction	56	67	Yes	Yes	Yes	Yes	57	68	Yes	Yes	Yes	Yes
174a	N84 Headford Road Junction South	68	70	Yes	Yes	No	No	68	70	Yes	Yes	No	No
174b	N84 Headford Road Junction South	58	63	Yes	Yes	Yes	Yes	59	64	Yes	Yes	Yes	Yes

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		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
175a	N84 Headford Road Junction South (to be demolished)	68	71	Yes	Yes	Yes	No	69	72	Yes	Yes	Yes	No
175b	N84 Headford Road Junction South (to be demolished)	66	69	Yes	Yes	Yes	No	66	70	Yes	Yes	Yes	No
176	N84 Headford Road Junction South	56	63	Yes	Yes	Yes	Yes	56	64	Yes	Yes	Yes	Yes
177a	N84 Headford Road Junction	62	66	Yes	Yes	Yes	Yes	62	67	Yes	Yes	Yes	Yes
177b	N84 Headford Road Junction	64	67	Yes	Yes	Yes	Yes	64	67	Yes	Yes	Yes	Yes
178	Ballindooley Boithrin / N84 Junction	52	63	Yes	Yes	Yes	Yes	52	63	Yes	Yes	Yes	Yes
179	Ballindooley / N84 Headford Road	65	66	Yes	No	No	No	66	67	Yes	No	No	No
180	Ballindooley/ N84 Headford Road	66	67	Yes	No	No	No	66	67	Yes	No	No	No
181	N84 Headford Road Junction	68	69	Yes	Yes	Yes	Yes	69	70	Yes	Yes	Yes	Yes
182	N84 Headford Road Junction	71	71	Yes	No	Yes	No	71	72	Yes	No	Yes	No
183	N84 Headford Road Junction	62	65	Yes	Yes	Yes	Yes	62	66	Yes	Yes	Yes	Yes
184	N84 Headford Road Junction (to be demolished)	61	66	Yes	Yes	Yes	No	62	66	Yes	Yes	Yes	No

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		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
185	Ballindooley/ N84 Headford Road	65	66	Yes	No	No	No	66	66	Yes	No	No	No
186	Ballindooley/ N84 Headford Road	68	68	Yes	No	No	No	68	69	Yes	No	No	No
187	Bóthar an Chóiste	51	60	No	Yes	Yes	No	52	61	Yes	Yes	Yes	Yes
188	Bóthar an Chóiste	49	62	Yes	Yes	Yes	Yes	49	63	Yes	Yes	Yes	Yes
189	Bóthar an Chóiste	47	59	No	Yes	Yes	No	48	60	No	Yes	Yes	No
190	Bóthar an Chóiste	49	61	Yes	Yes	Yes	Yes	49	62	Yes	Yes	Yes	Yes
191	Castlegar	47	63	Yes	Yes	Yes	Yes	47	64	Yes	Yes	Yes	Yes
192	Castlegar	48	67	Yes	Yes	Yes	Yes	48	68	Yes	Yes	Yes	Yes
193	Castlegar	48	63	Yes	Yes	Yes	Yes	48	63	Yes	Yes	Yes	Yes
194	School Road North	50	65	Yes	Yes	Yes	Yes	50	66	Yes	Yes	Yes	Yes
195a	School Road (to be acquired)	62	58	No	No	Yes	No	62	59	No	No	No	No
195b	School Road (to be acquired)	59	67	Yes	Yes	Yes	Yes	59	68	Yes	Yes	Yes	Yes
196	School Road North	49	64	Yes	Yes	Yes	Yes	50	65	Yes	Yes	Yes	Yes
197	Castlegar School	58	60	No	Yes	Yes	No	58	61	Yes	Yes	Yes	Yes
198a	Castlegar/ School Road South (to be acquired)	54	64	Yes	Yes	Yes	Yes	54	64	Yes	Yes	Yes	Yes

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		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
198b	Castlegar/ School Road South (to be acquired)	62	60	No	No	Yes	No	62	61	Yes	No	No	No
199	Castlegar School	50	58	No	Yes	Yes	No	50	59	No	Yes	Yes	No
200	Castlegar / School Road South (to be demolished)	57	64	Yes	Yes	Yes	No	57	64	Yes	Yes	Yes	No
201	Castlegar/ School Road South (to be demolished)	50	59	No	Yes	Yes	No	50	60	No	Yes	Yes	No
202	Castlegar/ School Road South	46	55	No	Yes	Yes	No	46	56	No	Yes	Yes	No
203	Castlegar	49	62	Yes	Yes	Yes	Yes	49	63	Yes	Yes	Yes	Yes
204	Castlegar / N83 Tuam Road	52	63	Yes	Yes	Yes	Yes	52	63	Yes	Yes	Yes	Yes
205	N83 Tuam Road South	70	71	Yes	No	Yes	No	70	71	Yes	No	Yes	No
206	Castlegar / N83 Tuam Road	59	64	Yes	Yes	Yes	Yes	59	65	Yes	Yes	Yes	Yes
207a	Castlegar/ N83 Tuam Road South	69	69	Yes	No	Yes	No	69	69	Yes	No	Yes	No
207b	Castlegar/ N83 Tuam Road South	61	63	Yes	Yes	Yes	Yes	62	64	Yes	Yes	Yes	Yes
208	Castlegar / N83 Tuam Road	56	67	Yes	Yes	Yes	Yes	56	67	Yes	Yes	Yes	Yes
209	City North Park Link Road	58	61	Yes	Yes	Yes	Yes	58	61	Yes	Yes	Yes	Yes

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		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
210	N6 Bothar na dTreabh	73	70	Yes	No	No	No	73	71	Yes	No	No	No
211	Monivea Road R339 west	55	53	No	No	No	No	55	53	No	No	No	No
212a	N83 Tuam Road North (rear)	53	65	Yes	Yes	Yes	Yes	53	66	Yes	Yes	Yes	Yes
212b	N83 Tuam Road North (front)	56	65	Yes	Yes	Yes	Yes	56	66	Yes	Yes	Yes	Yes
213a	N83 Tuam Road North/Ceapach na Boirne	70	69	Yes	No	Yes	No	70	69	Yes	No	Yes	No
213b	N83 Tuam Road North /Ceapach na Boirne	63	65	Yes	Yes	Yes	Yes	63	66	Yes	Yes	Yes	Yes
214	N83 Tuam Road North /Ceapach na Boirne	70	69	Yes	No	Yes	No	70	69	Yes	No	No	No
215	N83 Tuam Road North /Ceapach na Boirne	67	67	Yes	No	No	No	67	67	Yes	No	No	No
216	N83 Tuam Road North	68	68	Yes	No	No	No	68	68	Yes	No	No	No
217	The Meadows / N6 Bóthar na dtreabh	69	66	Yes	No	No	No	69	67	Yes	No	No	No
218	Galway Racecourse	48	56	No	Yes	Yes	No	49	57	No	Yes	Yes	No
219	N83 Tuam Road South	70	72	Yes	Yes	No	No	70	72	Yes	Yes	No	No
220	N83 Tuam Road North	66	66	Yes	No	No	No	66	66	Yes	No	No	No

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		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
221	Galway Racecourse	52	54	No	Yes	Yes	No	53	55	No	Yes	Yes	No
222	The Meadows / N6 Bóthar na dTreabh	68	65	Yes	No	No	No	68	66	Yes	No	No	No
223	N83 Tuam Road North	66	66	Yes	No	No	No	66	66	Yes	No	No	No
224	Racecourse Ave, Ballybrit	53	60	No	Yes	Yes	No	53	61	Yes	Yes	Yes	Yes
225	The Paddocks, N6 Bóthar na dTreabh	71	68	Yes	No	No	No	71	69	Yes	No	No	No
226	Galway Racecourse	54	54	No	No	Yes	No	54	55	No	No	Yes	No
227	Galway Racecourse	51	54	No	Yes	Yes	No	52	55	No	Yes	Yes	No
228	Racecourse Business Park (to be demolished)	51	64	Yes	Yes	Yes	No	51	65	Yes	Yes	Yes	No
229	Racecourse Ave, Ballybrit (to be demolished)	54	64	Yes	Yes	Yes	No	54	65	Yes	Yes	Yes	No
230	Racecourse Ave, Ballybrit	52	57	No	Yes	Yes	No	52	58	No	Yes	Yes	No
231	Racecourse Ave, Ballybrit	53	54	No	Yes	Yes	No	53	55	No	Yes	Yes	No
232	Racecourse Ave, Ballybrit	54	57	No	Yes	Yes	No	54	58	No	Yes	Yes	No
233	Ballybrit Crescent	58	60	No	Yes	Yes	No	58	61	Yes	Yes	Yes	Yes
234a	Ballybrit Crescent	63	62	Yes	No	No	No	63	62	Yes	No	No	No

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		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
234b	Ballybrit Crescent	53	61	Yes	Yes	Yes	Yes	54	61	Yes	Yes	Yes	Yes
235	Ballybrit Crescent	55	67	Yes	Yes	Yes	Yes	55	68	Yes	Yes	Yes	Yes
236	Ballybrit Crescent	53	61	Yes	Yes	Yes	Yes	53	62	Yes	Yes	Yes	Yes
237	An Sean Bhaile	69	69	Yes	No	Yes	No	70	69	Yes	No	No	No
238	Monieva Road R339, Ballybrit Crescent Junction	66	65	Yes	No	Yes	No	66	65	Yes	No	Yes	No
239	Monieva Road R339, Ballybrit Crescent Junction	67	66	Yes	No	Yes	No	66	67	Yes	No	Yes	No
240	An Sean Bhaile	70	66	Yes	No	No	No	71	67	Yes	No	No	No
241	Merlin Woods School	59	55	No	No	No	No	60	56	No	No	No	No
242	Monieva Road R339 East	56	60	No	Yes	Yes	No	56	61	Yes	Yes	Yes	Yes
243	Coolagh Village	55	57	No	Yes	Yes	No	55	58	No	Yes	Yes	No
244	Garran Iseal	69	70	Yes	Yes	No	No	69	71	Yes	Yes	No	No
245	Coolagh Village	55	60	No	Yes	Yes	No	56	60	No	Yes	Yes	No
246	Coolagh Village	56	61	Yes	Yes	Yes	Yes	57	62	Yes	Yes	Yes	Yes
247	Galway Clinic R446 Doughiska	63	66	Yes	Yes	No	No	63	66	Yes	Yes	No	No
248	Coolagh Village	53	57	No	Yes	Yes	No	54	57	No	Yes	Yes	No

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		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
249	Coolagh Village	54	57	No	Yes	Yes	No	55	57	No	Yes	Yes	No
250	Coolagh Village	53	53	No	No	Yes	No	53	54	No	No	Yes	No
251a	Menlough / Sean Bothar	42	66	Yes	Yes	Yes	Yes	42	67	Yes	Yes	Yes	Yes
251b	Menlough / Sean Bothar	47	66	Yes	Yes	Yes	Yes	47	67	Yes	Yes	Yes	Yes
252	Cappagh Road South	48	59	No	Yes	No	No	49	60	No	Yes	No	No
253	Cappagh Road South	51	58	No	Yes	No	No	51	58	No	Yes	No	No
254	Cappagh Road South	51	56	No	Yes	No	No	51	57	No	Yes	No	No
255a	Letteragh Road South	45	64	Yes	Yes	No	No	49	65	Yes	Yes	No	No
255b	Letteragh Road South	44	57	No	Yes	Yes	No	46	58	No	Yes	Yes	No
256	Cappagh Road South	37	58	No	Yes	Yes	No	37	58	No	Yes	Yes	No
257	Cappagh Road South	45	60	No	Yes	Yes	No	45	61	Yes	Yes	Yes	Yes
258	Parkmore Link Road	49	53	No	Yes	No	No	49	53	No	Yes	No	No
259	Troscaigh Thoir	43	61	Yes	Yes	Yes	Yes	43	61	Yes	Yes	Yes	Yes
260	Maoilin	34	59	No	Yes	Yes	No	34	60	No	Yes	Yes	No
261	Maoilin	36	58	No	Yes	Yes	No	36	59	No	Yes	Yes	No
262	Maoilin	36	59	No	Yes	Yes	No	36	59	No	Yes	Yes	No
263	Maoilin	35	61	Yes	Yes	Yes	Yes	36	62	Yes	Yes	Yes	Yes

Receiver Location Reference	Description	Opening Year 2024		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2039.		TII Condition for Noise Mitigation Satisfied?			Mitigation Required?
		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)		Predicted Noise Level. Do Minimum. dB L_{den}	Predicted Noise Level. Do-Something. dB L_{den}	(a)	(b)	(c)	
264	Maoilin	34	59	No	Yes	Yes	No	34	60	No	Yes	Yes	No
265	Maoilin	36	57	No	Yes	Yes	No	36	58	No	Yes	Yes	No
266	Maoilin	36	59	No	Yes	Yes	No	36	60	No	Yes	Yes	No
267	Maoilin	34	60	No	Yes	Yes	No	35	60	No	Yes	Yes	No
268	Maoilin	35	60	No	Yes	Yes	No	35	60	No	Yes	Yes	No
269	Maoilin	34	60	No	Yes	Yes	No	35	61	Yes	Yes	Yes	Yes
270	Coolagh	58	61	Yes	Yes	Yes	Yes	59	61	Yes	Yes	Yes	Yes

Model Results - Year 2024

On review of the modelled results and subsequent analysis, a total of 92 of the modelled locations satisfy the requirements for noise mitigation i.e. the predicted road traffic noise level is above 60dB L_{den} and noise levels are increased by 1dB or more as a direct result of the proposed road development. Noise mitigation is therefore deemed necessary at these locations based on the TII criteria. The number of properties determined to require noise mitigation excludes properties which will be demolished as part of the proposed road development but includes those that are to be acquired.

Model Results – Year 2039

On review of the modelled results and subsequent analysis, a total of 106 of the modelled locations satisfy the requirements for noise mitigation i.e. the predicted road traffic noise level is above 60dB L_{den} and noise levels are increased by 1dB or more as a direct result of the proposed road development. Noise mitigation is therefore deemed necessary at these locations based on the TII criteria. The number of properties determined to require noise mitigation excludes properties which will be demolished as part of the proposed road development but includes those that are to be acquired.

Summary of Receptors Requiring Mitigation

Analysis of the modelled results indicates that during the Design Year of 2039, 106 properties meet the three criteria for noise mitigation. These are distributed across the length of the proposed road development including the mainline, link roads and along existing roads which will be upgraded as part of the proposed road development.

Whilst the 106 properties identified satisfy the requirement for noise mitigation, the suitability and or practicality of noise mitigation for each location may not be possible at all locations. Further discussion on the recommended mitigation measures for the operational phase are included in **Section 17.6.3**.

17.5.4.2 Operational Vibration

As a vehicle travels along a road, vibration can be generated in the road and subsequently propagate towards nearby buildings. Such vibration is generated by the interaction of a vehicle’s wheels and the road surface and by direct transmission through the air of energy waves. Some of these waves arise as a function of the size, shape and speed of the vehicle, and others from pressure fluctuations due to engine, exhaust and other noises generated by the vehicle.

It has been found that ground vibrations produced by road traffic are unlikely to cause perceptible structural vibration in properties located near to well-maintained and smooth road surfaces. Perceptible road traffic vibration can therefore be largely avoided by maintenance of the road surface.

17.6 Mitigation Measures

17.6.1 Introduction

Mitigation measures for the construction and operational phases are set out below in order to reduce potential impacts as far as practicable to within the adopted design goals for noise and vibration.

17.6.2 Construction Phase

17.6.2.1 Noise

The contract documents will clearly specify the construction noise criteria included in this chapter which the construction works must operate within. The Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of *BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Noise* and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001. These measures will ensure that:

- No plant used on site will be permitted to cause an ongoing public nuisance due to noise
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use
- Any plant, such as generators or pumps that is required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen
- During the course of the construction programme, the contractor will be required to manage the works to comply with the limits detailed in **Table 17.1** using methods outlined in *BS 5228-1:2009+A1 2014. Part 1 - Noise*

BS 5228 *-1:2009+A1 2014* includes guidance on several aspects of construction site practices, which include, but are not limited to:

- Selection of quiet plant
- Control of noise sources
- Screening

- Hours of work
- Liaison with the public
- Monitoring

Further comment is offered on these items in the following paragraphs and in **Appendix A.17.2**, however specific control measures relating to construction activities undertaken by the contractor will be set out within the construction noise and vibration management plan. Noise control measures that will be considered include the selection of quiet plant, enclosures and screens around noise sources, limiting the hours of work and noise monitoring. The contractor will be required to conduct construction noise predictions prior to works taking place and put in place the most appropriate noise control measures depending on the level of noise reduction required at any one location.

Selection of Quiet Plant

The potential for any item of plant to generate noise will be assessed prior to the item being brought onto the site. The least noisy item of plant will be selected wherever possible. Should a particular item of plant already on the site be found to generate high noise levels, the first action will be to identify whether or not said item can be replaced with a quieter alternative.

For static plant such as compressors and generators used at work areas such as construction compounds etc., the units will be supplied with manufacturers' proprietary acoustic enclosures where possible.

The contractor will evaluate the choice of piling, excavation, breaking or other working method taking into account various ground conditions and site constraints. Where possible, where alternative lower noise generating equipment that would economically achieve, in the given ground conditions, equivalent structural / excavation / breaking results, these will be selected to minimise potential disturbance.

The decision regarding the type of pile, excavation technique, rock breaking, crushing etc. to be used on a site will normally be governed by other engineering, environmental constraints. In these instances, it may not be possible for technical reasons to replace a noisy process by a quieter alternative (e.g. rotary bored piling over driven piles). Even if it is possible, the adoption of a quieter method may prolong the overall process (e.g. manual rock breaking versus blasting); the net result being that the overall disturbance to the community will not necessarily be reduced.

General Comments on Noise Control at Source

If replacing a noisy item of plant is not a viable or practical option, consideration will be given to noise control "at source". This refers to the modification of an item of plant, or the application of improved sound reduction methods in consultation with the supplier or the best practice use of equipment and materials handling to reduce noise.

In practice, a balance may need to be struck between the use of all available techniques and the resulting costs of doing so. It is therefore proposed to adopt the concept of "*Best Available Techniques"*. as defined in EC Directive 96/61. In this context *"best"* means *"the most effective in achieving a high general level of protection of the environment as a whole"*.

The expression *"available techniques"* means *"those techniques developed on a scale which allows implementation…., under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced within the State, as long as they are reasonably accessible to the operator carrying on the activity"*.

The term *"techniques"* includes *"both the technology used and the way in which the installation is designed, built, managed, maintained, operated and decommissioned"*.

Thus, the concept of Best Available Techniques requires a degree of balance between the attainment of environmental benefits and the likely cost implications. In the identification of Best Available Techniques, regard will be had to a wide range of factors, however, emphasis will be given to *"practical suitability"* and the need *"to reduce an emission and its impact on the environment as a whole"*.

Proposed techniques will also be evaluated in light of their potential effect on occupational health and safety. The following outline guidance relates to practical noise control at source techniques which relate to specific site considerations:

- For mobile plant items such as cranes, dump trucks, excavators and loaders, the installation of an acoustic exhaust and/or maintaining enclosure panels closed during operation can reduce noise levels by up to 10dB. Mobile plant will be switched off when not in use and not left idling
- For piling plant, noise reduction can be achieved by enclosing the driving system in an acoustic shroud. For steady continuous noise, such as that generated by diesel engines, it is possible to reduce the noise emitted by fitting a more effective exhaust silencer system or utilising an acoustic canopy to replace the normal engine cover
- For percussive tools such as pneumatic concrete breakers, rock drills and tools a number of noise control measures include fitting muffler or sound reducing equipment to the breaker 'tool' and ensuring any leaks in the air lines are sealed. Erection of localised screens around breaker or drill bit when in operation in close proximity to noise sensitive boundaries are other suitable forms of noise reduction
- For concrete mixers, control measures will be employed during cleaning to ensure no impulsive hammering is undertaken at the mixer drum
- For all materials handling, the contractor will ensure that best practice site noise control measures are implemented including ensuring that materials are not dropped from excessive heights and drop chutes/dump trucks are lined with resilient materials. This is an important consideration for site compounds where materials are loaded and unloaded. Site compounds in close proximity to noise sensitive areas (refer to **Table 17.10**) will incorporate a strict noise control policy relating to materials handling

- Where compressors, generators and pumps are located in areas in close proximity to noise sensitive properties/ areas and have potential to exceed noise criterion, these will be surrounded by acoustic lagging or enclosed within acoustic enclosures providing air ventilation
- Resonance effects in panel work or cover plates can be reduced through stiffening or application of damping compounds; rattling and grinding noises can be controlled by fixing resilient materials in between the surfaces in contact
- Demountable enclosures can also be used to screen operatives using hand tools and may be moved around site as necessary
- All items of plant will be subject to regular maintenance. Such maintenance can prevent unnecessary increases in plant noise and can serve to prolong the effectiveness of noise control measures

Screening

Typically screening is an effective method of reducing the noise level at a receiver location and can be used successfully as an additional measure to other forms of noise control. The effectiveness of a noise screen will depend on the height and length of the screen, its mass, and its position relative to both the source and receiver.

The length of the screen should in practice be at least five times the height, however, if shorter sections are necessary then the ends of the screen will be wrapped around the source.

BS 5228 *-1:2009+A1 201* states that on level sites the screen should be placed as close as possible to either the source or the receiver. The construction of the barrier will be such that there are no gaps or openings at joints in the screen material. In most practical situations the effectiveness of the screen is limited by the sound transmission over the top of the barrier rather than the transmission through the barrier itself. In practice, screens constructed of materials with a mass per unit of surface area greater than 10kg/m^2 will give adequate sound insulation performance. As an example, the use of a standard 2.4m high construction site hoarding will provide a sufficient level of noise screening once it is installed at a suitable position between the source and receiver. Annex B of *BS 5228-1:2009+A1:2014* (Figures B1, B2 and B3) provide typical details for temporary and mobile acoustic screens, sheds and enclosures that can be constructed on site from standard materials.

In addition, careful planning of the site layout will also be considered. Within site compounds, the placement of site buildings such as offices and stores between the site and sensitive locations can provide a good level of noise screening. Similarly, in some instances materials such as topsoil or aggregate along the route of the proposed road development can provide a degree of noise screening if placed between the source and the receiver.

Hours of Work

Construction activity will mostly take place during daytime hours Monday to Friday and Saturdays (ref **Section 17.2.2.1**). Depending on the noise emission levels experienced and associated noise impact, the contractor will be flexible and able to conduct certain works at hours which reflect periods when the neighbouring properties have lower sensitivities to noise.

It will be necessary to work overtime (including weekends) and night shifts at certain critical stages during the project. Over the expected 36-month construction phase there will be up to 10 weeks of night time working along different sections of the proposed road development primarily to facilitate bridge works over existing roads.

Consideration will be given to the scheduling of activities in a manner that reflects the location of the site and the nature of neighbouring properties. Each potentially noisy event/activity will be considered on its individual merits and scheduled according to its noise level, proximity to sensitive locations and possible options for noise control. In situations where a particularly noisy activity is scheduled e.g. activities identified in **Table 17.9** (rock breaking/crushing/impact piling etc.) or other activities of similar noise level, the use of other on-site activities will be scheduled to ensure control cumulative noise levels.

Liaison with the Public

On typical road construction sites, the major sources of noise are essentially mobile and the noise received at any control points will therefore vary from day to day as work proceeds. The duration of piling, excavation, breaking and other high noise or vibration activities works is usually short in relation to the length of construction work as a whole, and the amount of time spent working near to sensitive areas can represent only a part of the overall period. It is important, therefore, that clear forms of communication are established between the contractor and noise sensitive areas in proximity so that residents or building occupants are aware of the likely duration of activities likely to generate higher noise or vibration.

A designated noise liaison officer will be appointed to site during construction works. All noise complaints will be logged and followed up in a prompt fashion by the liaison officer.

Monitoring

During the construction phase noise monitoring will be undertaken at the nearest sensitive locations to ensure construction noise limits outlined in **Table 17.1** are not exceeded. Noise monitoring will be conducted in accordance with the International Standard ISO 1996: *Acoustics – Description, measurement and assessment of environmental noise* Part 1 (2016) and Part 2 (2017). The selection of monitoring locations will be based on the nearest sensitive buildings to the working area which will progress along the length of the road construction.

It is recommended that noise control audits are conducted at regular intervals throughout the construction programme in conjunction with noise monitoring. The purpose of the audits will be to ensure that all appropriate steps are being taken to control construction noise emissions and to identify opportunities for improvement, where required.

17.6.2.2 Blasting and Air Overpressure

Air overpressure from a blast is difficult to control because of its variability, however, much can be done to reduce the effect and the control of the blast design at source.

In terms of blast design control, specific guidance will be obtained from the recommendations contained within *BS 5228-2:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Vibration* in relation to blasting operations in addition to experienced blast control techniques used by the contractor. These will include some or all of the following:

- All blasting will be undertaken by professionally trained blast contractors
- Restriction of hours within which blasting can be conducted (09:00 – 18:00hrs)
- Trial blasts will be tested in less sensitive areas to assist in blast designs and identify potential zones of influence
- Explosive charges will be properly confined by a sufficient amount of stemming
- Blasting contractors will ensure that the minimum amount of primer cord is used, and that no primer cord is located above ground
- Profiling will be carried out after each blast in order to ensure the geometry of the rock face can be established, enabling the optimum burden and spacing to be applied for subsequent blasts
- The design, execution and completion of any blasting within 150metres of any existing structure shall require special considerations. This will include the use of pre and post condition structural surveys by a competent structural engineer
- Ground vibration and air over pressure (AOP) will be recorded simultaneously for each blast at the most sensitive locations, depending on the works area being blasted
- When blasting moves into a new area, an initial low level blast will be carried out (i.e. a low Maximum Instantaneous Charge (MIC)) and monitoring will be carried out simultaneously at a number of sensitive properties in different directions in order to generate specific scaled distance graphs
- The scaled distance graphs will be used to determine the optimum MIC for subsequent blasts area in order control vibration and AOP limits below the relevant limit values (as set out in **Section 17.2.1**) at the nearest sensitive buildings

In line with best practice mitigation measures from vibration sources, good communication and public relations are a key factor in reducing any startle effects to residents. In this instance, a Public Communications Strategy will be implemented by the contractor prior to the commencement of any blast works. In such cases, the following recommended mitigation measures are proposed:

- Relevant nearby residents will be notified before any work and blasting starts (e.g. a minimum of 24-hour written notification)

- The firing of blasts will be undertaken, where possible, at similar times to reduce the 'startle' effect
- Ongoing circulars will be issued informing people of the progress of the blasting works
- The implementation of an onsite documented complaints procedure will be maintained by the contractor
- The use of independent monitoring will be undertaken by external bodies for verification of results

17.6.2.3 *Vibration*

The TII Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities should be limited to the values set out in **Table 17.3**.

On review of the likely vibration levels associated with construction activities, it may be concluded that the construction of the proposed road development is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or cosmetic damage to buildings.

In the case of vibration levels giving rise to human discomfort, in order to minimise such impacts, the following measures shall be implemented during the construction period:

- A clear communication programme will be established to inform adjacent building occupants in advance of any potential intrusive works which may give rise to vibration levels likely to exceed perceptible levels. The nature and duration of the works will be clearly set out in all communication circulars
- Alternative less intensive working methods and/or plant items shall be employed, where feasible
- Appropriate vibration isolation shall be applied to plant, where feasible
- Cut off trenches to isolate the vibration transmission path shall be installed where required
- In the case of impact piling or demolition works for instance, a reduction in the input energy per blow shall be considered where required
- Monitoring will be undertaken at identified sensitive buildings, where proposed works have the potential to be at or exceed the vibration limit values

Property Condition Surveys

Property condition surveys will be offered for all buildings within 50m of the proposed development boundary and those within 150m of proposed blasting works along the proposed road development. Property condition surveys will also be carried out at buildings and structures considered appropriate relative to their proximity to the works. Such property condition surveys shall be carried out by a Chartered Surveyor or Chartered Structural Engineer. Such property condition surveys, subject to the written agreement of relevant property owners, shall be carried out in two stages as the follows:

- the first stage shall consist of pre-construction condition surveys including photographic records which shall be carried out prior to the commencement of construction
- the second stage shall consist of post-construction condition surveys which shall include photographic records

Disturbance of Particularly Vibration-Sensitive Equipment and Processes

The location of potentially vibration sensitive activities have been identified for manufacturing facilities within the Parkmore and Racecourse Business Parks. This location is in proximity to an area where blasting will take place as part of the proposed tunnel at Ballybrit. The most effective form of mitigation for this type of sensitive process is through on-going consultation with the property owners as the design and construction of the proposed road development progresses. This will involve baseline vibration monitoring and the use of trial blasts using an initial low level charge with simultaneously vibration measurements undertaken at the building. This information will be used to determine acceptable vibration levels for the facility relating to the sensitivity of the operating equipment. The results of this trial assessment will then set appropriate agreed limits values at the facility in question which will be monitored during subsequent blasts or other excavation methodologies. Where no safe limit is determined, the timing and scheduling of blasts will be undertaken in consultation with the facility when no sensitive operations are taking place. Given the short time period over which an individual blast takes place (i.e. a number of seconds), this approach is deemed to be feasible.

17.6.3 Operational Phase

The following section details the mitigation measures deemed practicable to achieve the design goals previously defined in **Section 17.2**.

The mitigation measures required to reduce traffic noise levels are specified based on the predicted noise levels for the Design Year of 2039. The results of the modelling exercise show that noise mitigation is required for 106 properties along the proposed route of the proposed road development for this Design Year.

Options to reduce operational noise levels along the proposed road development include the use of a Low Noise Road Surface (LNRS) to reduce noise generated at source and the use of noise barriers to reduce noise levels along the propagation path between the source (proposed road development) and the specific receivers (houses, schools, churches etc.). These screens may be constructed as earth bunds, proprietary noise barriers or a combination of both.

As part of the assessment, therefore, the use of a low noise road surface (LNRS) providing a mean reduction in traffic noise level of -2.5dB compared to Hot Rolled Asphalt (HRA) has been modelled along the length of the mainline of the proposed road development and the main junction slip roads accessing the N59 Moycullen Road, N84 Headford Road, N83 Tuam Road and existing N6 in addition to the N59 Link Road North and South as part of the proposed road development. **Table 17.14** summarises the noise barrier requirements for the proposed road development required in addition to the use of a low noise road surface.

Table 17.14: Likely Extent of Noise Screening

Receiver No.	Structure Name	Start Chainage	End Chainage	Height (m)	Location	Lateral Siting / Type
7 & 6	NB00/01	0+015	0+120	2	R336 West of Bearna West Roundabout	Westbound/Standard
8	NB00/02	0+000	0+100	2	R336 East of Bearna West Roundabout	Eastbound/ Standard
27	NB01/01	1+030	1+145	2	Proposed Road Development Mainline	Eastbound/ Standard
40	NB01/02	1+520	1+735	2	Proposed Road Development Mainline	Westbound/ Standard
63a/63b	NB04/01	4+370	4+450	2.5	Proposed Road Development Mainline	Eastbound/ Standard
	NB04/02	0+095	0+130	2	Cappagh Road North of Cappagh Road Junction	Northbound/ Standard
	NB04/03	0+080	0+090	2	Cappagh Road North of Cappagh Road Junction	Northbound/ Standard
66a/66b	NB04/04	4+460	4+535	1.5	Proposed Road Development Mainline	Westbound/ Standard
	NB04/05	0+185	0+225	2.5	Cappagh Road South of Cappagh Road Junction	Southbound/ Standard
	NB04/06	0+140	0+185	2.5	Cappagh Road South of Cappagh Road Junction	Southbound/ Standard
74a/74b/75a	NB05/01	5+525	5+615	3.5	Proposed Road	Westbound/ Standard

Receiver No.	Structure Name	Start Chainage	End Chainage	Height (m)	Location	Lateral Siting / Type
					Development Mainline	
	NB05/02	0+080	0+110	3	Ballymoneen Road south of Ballymoneen Road Junction	Northbound/ Standard
	NB05/03	0+000	0+060	2.5	Ballymoneen Road south of Ballymoneen Road Junction	Northbound/ Standard
80a/80b	NB05/04	5+660	5+750	2.5	Proposed Road Development Mainline	Eastbound/ Standard
	NB05/05	0+145	0+160	2	Ballymoneen Road north of Ballymoneen Road Junction	Southbound/ Standard
	NB05/06	0+170	0+225	2	Ballymoneen Road north of Ballymoneen Road Junction	Southbound/ Standard
86	NB05/07	5 +910	6+110	2	Proposed Road Development Mainline	Westbound/ Standard
96	NB06/01	6+400	6+555	2	Proposed Road Development Mainline	Eastbound/ Standard
106	NB06/02	6+870	7+100	2	Proposed Road Development Mainline	Westbound / Standard
107	NB07/01	7+165	7+210	2.5	Proposed Road Development Mainline	Eastbound/ Standard
	NB07/02	0+000 7+210	0+250 7+260	2.5	N59 Letteragh Junction EB diverge	Eastbound/ Standard

Receiver No.	Structure Name	Start Chainage	End Chainage	Height (m)	Location	Lateral Siting / Type
109/110	NB07/03	7+180	7+440	2	Proposed Road Development Mainline	Westbound/ Standard
120a/120b	NB07/04	1+415	1+470	2	N59 Link Road South	Southbound/ Standard
	NB07/05	0+105	0+175	2	Letteragh Road L1323	Eastbound/ Standard
255a	NB07/06	0+030	0+065	2	Letteragh Road L1323	Eastbound/ Standard
	NB07/07	0+000	0+025	2	Letteragh Road L1323	Eastbound/ Standard
135/137/145/146a/ 146b/149/150/ 151b/151a/155	NB08/01	0+060	0+000	2.5	N59 Letteragh Junction WB diverge	Westbound /Absorptive
		8+010	8+070			
	NB08/02	8+070	8+280	2.5	Proposed Road Development Mainline	Westbound /Absorptive
	NB08/03	8+280	8+540	3	Proposed Road Development Mainline	Westbound/ Absorptive
140/142	NB08/04	8+100	8+230	3.5	Proposed Road Development Mainline	Eastbound /Absorptive
	NB08/05	8+230	8+375	4	Proposed Road Development Mainline	Eastbound/ Absorptive
	NB08/06	8+375	8+405	3.5	Proposed Road Development Mainline	Eastbound/ Absorptive
148a/153/156/158	NB08/07	8+545	8+850	2.5	Proposed Road Development Mainline	Eastbound/ Reflective
	NB08/08	8+850	9+500	2	Proposed Road Development Mainline	Eastbound/ Reflective
151/155	NB08/09	8+540	8+760	2.5	Proposed Road Development Mainline	Westbound/ Reflective

Receiver No.	Structure Name	Start Chainage	End Chainage	Height (m)	Location	Lateral Siting / Type
158	NB08/10	8+760	8+790	2	Proposed Road Development Mainline	Westbound/ Reflective
158/160	NB08/11	8+850	9+500	2	Proposed Road Development Mainline	Westbound/ Reflective
144/147/148a	NB08/12	8+405	8+525	3	Proposed Road Development Mainline	Eastbound/ Absorptive
	NB08/13	8+525	8+545	2.5	Proposed Road Development Mainline	Eastbound/ Reflective
158	NB08/14	8+800	8+850	2	Proposed Road Development Mainline	Westbound/ Reflective
168	NB09/01	9+990	10+100	1.5	Proposed Road Development Mainline	Eastbound/ Reflective
170/251a/251b	NB10/01	10+420	10+780	3	Proposed Road Development Mainline	Westbound/ Reflective
173/177/178	NB11/01	11+910	12+120	3.5	Proposed Road Development Mainline	Eastbound/ Reflective
174a	NB11/02	11+980	12+120	2.5	Proposed Road Development Mainline	Westbound/ Reflective
182/183	NB12/01	12+140	12+350	3	Proposed Road Development Mainline	Eastbound/ Absorptive
174a/174b/176	NB12/02	0+180	0+350	2	N84 Headford Road Junction WB diverge	Westbound/ Reflective
177a/177b	NB12/03	0+050	0+080	2	N84 Headford Road	Northbound/ Reflective

Receiver No.	Structure Name	Start Chainage	End Chainage	Height (m)	Location	Lateral Siting / Type
173/177a	NB12/04	0+090	0+150	2	N84 Headford Road	Northbound/ Reflective
191/192/193	NB12/05	12+910	13+020	2.5	Proposed Road Development Mainline	Westbound/ Absorptive
194/195/196	NB12/06	12+870	13+050	3.5	Proposed Road Development Mainline	Eastbound/ Absorptive
174a/174b/176	NB12/07	12+140	12+350	2.5	Proposed Road Development Mainline	Westbound/ Absorptive
192/193/198a	NB13/01	13+020	13+165	3	Proposed Road Development Mainline	Westbound/ Absorptive
194/195/196	NB13/02	13+050	13+120	3	Proposed Road Development Mainline	Eastbound/ Absorptive
197	NB13/03	13+160	13+370	2	Proposed Road Development Mainline	Eastbound/ Reflective
203/204/206/208	NB13/04	13+360	13+640	3	Proposed Road Development Mainline	Westbound/ Reflective
	NB13/05	13+590	13+935	3.5	Proposed Road Development Mainline	Westbound/ Absorptive
	NB13/06	0+240	0+000	3	N83 Tuam Road Junction WB merge	Westbound/ Reflective
		13+640	13+840			
212/213b	NB13/07	13+620	13+960	3.5	Proposed Road Development Mainline	Eastbound/ Absorptive
224-235	NB15/01	15+200	15+720	2.5	Proposed Road Development Mainline	Eastbound/ Reflective

The proposed noise mitigation set out above have been designed to sufficiently reduce traffic noise levels at or below the traffic noise design goal of 60dB L_{den}, where relevant.

The combined mitigation measures associated with the use of a LNRS surface in addition to physical noise screening has been assessed to provide the most suitable available noise mitigation at the nearest sensitive locations. Discussion on the residual impacts taking account of the proposed mitigation measures are outlined in **Section 17.7.2**.

17.7 Residual Impacts

17.7.1 Introduction

The residual impacts associated with the construction and operational phase are considered taking account of the proposed mitigation measures. These are discussed in the following sections.

17.7.2 Construction Phase

During the construction phase of the proposed road development noise levels at properties closest to working areas will be temporarily increased. The assessment has indicated that construction activities can, for the majority of activities operate within the adopted noise limits for daytime periods at the nearest properties to the works. Given the linear nature of the works, noise emissions related to construction works will be of short term impact at any one area as the works progress along the length of the proposed road development. The most appropriate noise mitigation measures for each work area will be determined taking account of the various control measures included within **Section 17.6.2**, **Appendix A.17.3** and the CEMP in **Appendix A.7.5**. The various mitigation measures will be selected in order to control construction noise levels to within the limit values included in **Table 17.1**.

Once the various mitigation measures are put in place and the limit values complied with, noise impacts associated with the construction phase will be of moderate to major, short term impact. Highest noise impacts will occur during periods of excavation, particularly in areas where sections of hard rock are to be excavated. As noted within the earlier section, the use of drill and blast methods will likely be chosen in these areas. Whilst high noise levels are associated with an individual blast, the effects are momentary and the blast designs will be strictly controlled to ensure the AOP and PPV levels are within the specified limit values. The use of this form of rock breaking will expedite the level of rock extraction in any one any and hence reducing overall exposure times and overall impacts. Mechanical breaking, crushing and excavation of rock and materials will be strictly controlled through the use of control of noise at source, screening, scheduling of works to ensure noise limit values at the closest sensitive properties are not exceeded.

The assessment has indicated that the use of standard construction activities can operate comfortably within the recommended vibration limits for standard residential and other light-framed buildings. With the adoption of best practice methodologies for the control of vibration from blasting, potential vibration impacts at the most sensitive premises can be adequately mitigated to within acceptable levels.

17.7.3 Operational Phase

The residual impacts associated with the proposed road development have been assessed for each modelled location. A full set of calculated residual noise levels for the 299 receiver locations are included in **Table A.17. 2.1** in **Appendix A.17.3**.

Table 17.15 overleaf presents the calculated residual noise levels for those locations where the conditions for mitigation were identified.

Table 17.15: Calculated Residual Noise Levels for Locations Requiring Noise Mitigation

Receiver Location Reference	Description	Opening Year 2024		Design Year 2039		Comment
		Predicted Noise Level		Predicted Noise Level		
		Do-Minimum	Do-Something	Do-Minimum	Do-Something	
		(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	
7	R336 West of Bearna West Roundabout	57	56	58	57	Meets design goal.
8	R336 East of Bearna West Roundabout	58	56	59	57	Meets design goal.
13	Na Foraí Maola Thoir	35	59	36	60	Meets design goal.
27	Na Foraí Maola Thiar (to be acquired)	44	58	44	59	Meets design goal.
40	Troscaigh Road	38	55	38	56	Meets design goal.
46	Troscaigh- Ann Gibbons Road	34	58	34	59	Meets design goal.
63a	Cappagh Road North	49	60	49	61	0.5dB above design goal. Mitigation in place.
63b	Cappagh Road North	49	58	49	59	Meets design goal.
65a	Cappagh Road North	47	56	48	57	Meets design goal.
65b	Cappagh Road North	39	58	39	58	Meets design goal.
66a	Cappagh Road South	44	58	45	59	Meets design goal.
66b	Cappagh Road South	48	59	48	60	Meets design goal.
67a	Cappagh Road South	45	59	45	59	Meets design goal.
74a	Ballymoneen Road South	50	59	51	59	Meets design goal.
74b	Ballymoneen Road South	35	59	35	59	Meets design goal.
75a	Ballymoneen Road South	52	59	52	60	Meets design goal.

Receiver Location Reference	Description	Opening Year 2024		Design Year 2039		Comment
		Predicted Noise Level		Predicted Noise Level		
		Do-Minimum	Do-Something	Do-Minimum	Do-Something	
		(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	
76	Ballymoneen Road North	51	60	51	60	Meets design goal.
79	Ballymoneen Road North	53	61	53	62	2dB above design goal. Dominated by traffic along Ballymoneen Road, property located outside the proposed development boundary
80a	Ballymoneen Road North	53	61	53	62	2dB above design goal. Dominated by traffic along Ballymoneen Road. Property access restricts additional mitigation
80b	Ballymoneen Road North	47	60	47	60	Meets design goal.
86	Árd na Gaoithe - Ballymoneen	39	57	39	57	Meets design goal.
88	Árd na Gaoithe - Ballymoneen	40	56	40	56	Meets design goal.
95	Clybaun Road North	42	56	42	57	Meets design goal.
96	Clybaun Road North	45	57	45	57	Meets design goal.
106	Between Rahoon & Letteragh Road	36	58	37	59	Meets design goal.
107	Letteragh Road North	43	58	46	59	Meets design goal.
108	Letteragh Road North	42	57	44	58	Meets design goal.
109	Letteragh Road South	42	57	44	58	Meets design goal.
110	Letteragh Road South	43	59	44	60	Meets design goal.
116	Knocknabrona (to be acquired)	36	59	37	60	Meets design goal.
118	Knocknabrona (to be acquired)	36	58	37	58	Meets design goal.

Receiver Location Reference	Description	Opening Year 2024		Design Year 2039		Comment
		Predicted Noise Level		Predicted Noise Level		
		Do-Minimum	Do-Something	Do-Minimum	Do-Something	
		(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	
120a	Letteragh Road South	45	58	48	59	Meets design goal.
120b	Letteragh Road South	44	58	46	59	Meets design goal.
134	Barnacranny	41	54	41	55	Meets design goal.
136	Barnacranny	50	58	51	59	Meets design goal.
138	The Heath	44	59	44	60	Meets design goal.
139	N59 Moycullen Road/ Árd na Locha	61	61	62	61	In line with Do Minimum scenario. No further mitigation
140	Barnacranny	49	60	50	61	1dB above design goal. Substantial mitigation in place.
142	N59 Moycullen Road/ Árd na Locha	51	58	51	58	Meets design goal.
144a	Árd an Locha (to be acquired)	55	58	55	59	Meets design goal.
144b	Árd an Locha (to be acquired)	58	58	58	59	Meets design goal.
145	The Heath	47	57	47	58	Meets design goal.
146a	Árd an Locha	46	56	46	57	Meets design goal.
146b	Árd an Locha	50	59	51	59	Meets design goal.
147a	Árd an Locha	59	60	60	60	Meets design goal.
148a	N59 Moycullen Road/ Aughnacurra	62	61	62	61	In line with Do Minimum scenario.
149	Circular Road Upper Dangan	47	56	48	57	Meets design goal.

Receiver Location Reference	Description	Opening Year 2024		Design Year 2039		Comment
		Predicted Noise Level		Predicted Noise Level		
		Do-Minimum	Do-Something	Do-Minimum	Do-Something	
		(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	
150	St. James' National School Upper Dangan	48	56	48	56	Meets design goal.
151a	Upper Dangan /N59 Moycullen Road	60	62	60	62	2dB above design goal. Traffic along local road (N59 Moycullen Road), minor difference between Do-Nothing and Do-Something scenarios
151b	Upper Dangan /N59 Moycullen Road	57	60	58	60	Meets design goal.
152	Aughnacurra	49	54	49	54	Meets design goal.
153	Aughnacurra (to be acquired)	56	59	57	60	Meets design goal.
154	Aughnacurra	51	57	52	58	Meets design goal.
155	Upper Dangan/N59 Moycullen Road	61	62	62	63	Along N59 Moycullen Road, minor increase.
156	Aughnacurra	45	56	45	57	Meets design goal.
157	N59 Moycullen Road	64	63	64	63	Reduced to below / in line with Do Min. Dominated by N84 Headford Road Traffic
158	NUIG	49	59	50	60	Meets design goal.
160	NUIG	46	57	46	58	Meets design goal.
162	N59 Moycullen Road/NUIG	59	60	60	60	Meets design goal.
163	Dangan House	43	55	44	56	Meets design goal.
165	Menlo Castle	45	55	45	56	Meets design goal.

Receiver Location Reference	Description	Opening Year 2024		Design Year 2039		Comment
		Predicted Noise Level		Predicted Noise Level		
		Do-Minimum	Do-Something	Do-Minimum	Do-Something	
		(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	
167	Menlough/ Bóthar Nua	42	56	43	57	Meets design goal.
168	Coolough Road	42	59	42	59	Meets design goal.
170	Menlough / Seanbothar	55	60	55	61	0.5dB above design goal, not significant.
173	Ballindooley Boithrin / N84 Junction	56	60	57	61	1dB above design goal, not significant.
174b	N84 Headford Road Junction South	58	60	59	60	Meets design goal.
176	N84 Headford Road Junction South	56	58	56	59	Meets design goal.
177a	N84 Headford Road Junction	62	61	62	61	Reduced to below / in line with Do Min
177b	N84 Headford Road Junction	64	63	64	63	Reduced to below / in line with Do Min
178	Ballindooley Boithrin / N84 Junction	52	57	52	58	Meets design goal.
181	N84 Headford Road Junction	68	68	69	69	Reduced to Do Min level. Dominated by N84 Headford Road Traffic
183	N84 Headford Road Junction	62	62	62	62	Reduced to Do Min level. Dominated by N84 Headford Road Traffic
187	Bóthar an Chóiste	51	57	52	57	Meets design goal.
188	Bóthar an Chóiste	49	59	49	60	Meets design goal.
190	Bóthar an Chóiste	49	58	49	59	Meets design goal.
191	Castlegar	47	57	47	58	Meets design goal.
192	Castlegar	48	58	48	59	Meets design goal.

Receiver Location Reference	Description	Opening Year 2024		Design Year 2039		Comment
		Predicted Noise Level		Predicted Noise Level		
		Do-Minimum	Do-Something	Do-Minimum	Do-Something	
		(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	
193	Castlegar	48	55	48	56	Meets design goal.
194	School Road North	50	60	50	60	Meets design goal.
195 b	School Road (to be acquired)	59	62	59	62	2dB above design goal. Property to be acquired. Substantial mitigation in place.
196	School Road North	49	58	50	59	Meets design goal.
197	Castlegar School	58	58	58	58	Meets design goal.
198a	Castlegar/ School Road South (to be acquired)	54	60	54	61	0.5dB above design goal. Property to be acquired
203	Castlegar	49	57	49	57	Meets design goal.
204	Castlegar / N83 Tuam Road	52	57	52	58	Meets design goal.
206	Castlegar / N83 Tuam Road	59	60	59	61	Minor increase due to traffic along N83 Tuam Road
207b	Castlegar/ N83 Tuam Road South	61	60	62	60	Reduced to below Do Min. Dominated by N83 Tuam Road.
208	Castlegar / N83 Tuam Road	56	60	56	61	1dB above design goal. Substantial mitigation in place
209	City North Park Link Road	58	58	58	59	Meets design goal.
212a	N83 Tuam Road North (rear)	53	59	53	60	Meets design goal.
212b	N83 Tuam Road North (front)	55	60	55	61	1dB above design goal.

Receiver Location Reference	Description	Opening Year 2024		Design Year 2039		Comment
		Predicted Noise Level		Predicted Noise Level		
		Do-Minimum	Do-Something	Do-Minimum	Do-Something	
		(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	(dB) L_{den}	
213b	N83 Tuam Road North/Ceapach na Boirne	63	62	63	63	In line with Do Minimum scenario.
224	Racecourse Ave, Ballybrit	53	56	53	57	Meets design goal.
233	Ballybrit Crescent	58	58	58	58	Meets design goal.
234b	Ballybrit Crescent	53	56	54	56	Meets design goal.
235	Ballybrit Crescent	55	58	55	59	Meets design goal.
236	Ballybrit Crescent	53	55	53	56	Meets design goal.
242	Monivea Road R339 East	56	58	56	58	Meets design goal.
246	Coolagh Village	56	59	57	60	Meets design goal.
251a	Menlough / Seanbothar	42	57	42	58	Meets design goal.
251b	Menlough / Seanbothar	47	58	47	59	Meets design goal.
257	Cappagh Road South	45	59	45	59	Meets design goal.
259	Troscaigh Thoir	43	58	43	59	Meets design goal
263	Maoilin	35	59	36	59	Meets design goal
269	Maoilin	34	58	35	59	Meets design goal
270	Coolagh	58	59	59	59	Meets design goal

17.7.3.1 Residual Noise Level

The results of the assessment have indicated that along the length of the proposed road development, traffic noise levels at or below 60dB L_{den} can be achieved, and/or the Do-Something noise levels can be reduced to the equivalent Do-Nothing traffic noise levels at the majority of locations with the recommended mitigation measures in place.

There are a small number of instances where a residual noise level of 1 to 2dB above the design goal remains. These locations primarily relate to properties which are to be acquired (R195, 198a), remain dominated by traffic along the local road network which falls outside the proposed development boundary (R79, R206), or where access onto the local road restricts physical additional mitigation (R63a, R80a). There are a small number of properties along the proposed road development where a residual noise level of 61 to 62dB L_{den} is calculated (R140, 151a, 155, 170, 173, 208 and 212). Whist these exceedances are strictly above the design goal, reducing traffic noise levels to at or below 60dB L_{den} at these properties will require substantial additional barrier lengths and heights over and above those in place in order to achieve an insignificant change to the overall noise level at a property.

The 2004 TII noise guidance document notes the following with respect to achievement of the noise design goal:

> *"The Authority accepts that it may not always be sustainable to provide adequate mitigation in order to achieve the design goal. Therefore, a structured approach should be taken in order to ameliorate as far as practicable."*

The 2014 noise guidance document notes that:

> *"in some cases the attainment of the design goal may not be possible by sustainable means".*

This guidance document also notes that caution should be exercised specifying substantial screening where small benefits (<3dB) are only achieved, given a change of 3dB(A) is the smallest change that would give a reliable difference in public response. Specifically, the TII 2014 document goes on to note that:

> *"It may be unsustainable to increase barrier dimensions significantly where the result would be a reduction of 1dB or less, as such a reduction would be close to imperceptible in a laboratory situation, and would not result in a difference in public response in the real world environment."*

In this instance, the extent of screening deemed feasible to achieve the target design goal at the relevant properties has been assessed, taking into account a level of proportionality with respect to changes in noise levels.

17.7.3.2 Evaluation of Residual Impacts

Section 17.7.3.1 presents the residual noise levels once noise mitigation has been included along the length of the proposed road development including a low noise road surface and an extensive number of acoustic barriers. As noted in the previous section, with the inclusion of the noise mitigation measures, noise levels are at or below the TII operational noise design goal of 60dB L_{den} at the majority of assessment locations (properties, schools, churches etc.) or have been reduced to within or below the pre-existing noise level.

In line with the methodology outlined in **Section 17.2.5.3**, in order to evaluate the significance of noise impacts, the following approach has been undertaken.

- Baseline noise levels (or Calculated Do-Minimum noise levels where road traffic dominates) are compared against the calculated Do-Something noise levels to determine the increase in noise levels
- The significance of change is assigned to each location based on the magnitude of change ratings from the DMRB short term table (Year of Opening) and long-term table (Design Year)
- Comment on the absolute noise levels against annoyance levels from population response studies

Table 17.16 summarises the number of properties categorised within each rating band for the year of opening and the Design Year based on the DMRB assessment tables only.

Table 17.16: Change in Noise Levels

Short-Term Impacts – Year of Opening			**Long-Term Impacts - Design Year**		
Noise Change, dB	**Magnitude**	**No of assessed properties**	**Noise Change, dB**	**Magnitude**	**No of assessed properties**
0	No Change/Reduction	99	0	No Change/Reduction	83
0.1 - 0.9	Negligible	18	0.1 – 2.9	Negligible	45
1 – 2.9	Minor	17	3 – 4.9	Minor	28
3 – 4.9	Moderate	31	5 – 9.9	Moderate	90
5+	Major	134	10+	Major	53
Total		299			299

During the Year of Opening (2024), the assessment has concluded that, 134 of the modelled receptors will experience a ‘Major’ short-term noise impact, which relates to any noise increase above 5dB. A total of 31 locations will experience a ‘Moderate’ noise impact as a result of the change in the noise environment. At the remaining locations, the impacts are categorised as ‘No Change’ to ‘Minor’.

During the Design Year of 2039, the assessment has concluded that 53 of the modelled receptors will experience a ‘Major’ long-term noise impact in accordance with the DMRB, which relates to any noise increase above 10dB. A total of 90 locations will experience a 'Moderate' noise impact as a result of the change in the noise environment. At the remaining locations, the impacts are categorised as 'No Change/Reduction' to 'Minor'. Assessment locations where a reduction in noise levels are calculated relate to properties along the existing road network where traffic volumes will be reduced as a result of the proposed road development.

Further analysis of the absolute noise levels for properties assigned a Moderate and Major change in noise levels for the two assessment years is presented in **Tables 17.17** and **17.20**, in order to provide context on the likely level of annoyance response relating to road traffic noise level exposure based on the EEA exposure-response studies, as discussed **in Section 17.2.5.3**.

Table 17.17: Assessment of Absolute Noise Level Annoyance Levels relating to Moderate Change in Noise Levels – 2024

Locations with Moderate Change in Noise Levels - Opening Year – 2024					
Change in Noise Level, Impact Rating	**Calculated Noise Levels**	**No properties**	**% Population 'Annoyed'**	**% Population 'Highly Annoyed'**	**Receptor Type, Comments**
Moderate	48	1	9	3	Residential
	49	1	10	3	Residential
	50	3	11	4	Residential
	51	1	12	4	Residential
	52	1	13	5	Residential
	53	1	15	5	Residential
	54	4	16	6	Residential
	55	3	18	6	Residential
	56	4	19	7	Residential
	57	2	21	8	Residential. 1 Amenity & Community facility (Moderate sensitivity)
	58	1	22	9	Residential
	59	4	24	9	Residential. 1 property to be acquired
	60	3	26	10	Residential
	61	1	27	11	Residential property to be demolished
	62	1	29	12	Residential property to be acquired

Reference to **Table 17.17** above indicates that where a 'Moderate' change in noise levels has been determined in accordance with the DMRB short-term assessment table, absolute noise levels are calculated in the range of 49 to 60dB L_{den} (excluding properties being acquired or demolished as part of the proposed road development).

The majority of assessment locations are residential properties (high sensitivity) and all residential properties in this category are below the TII design goal of 60dB L_{den}.

There is one amenity/community area at NUIG Sporting Campus categorised as moderate sensitivity. The calculated noise level in this area is 57dB L_{den} which is considered an acceptable noise level for outdoor amenity use.

Table 17.18: Assessment of Absolute Noise Level Annoyance Levels relating to Major Change in Noise Levels – 2024

Locations with Major Change in Noise Levels - Opening Year – 2024					
Change in Noise Level, Impact Rating	**Calculated Noise Levels**	**No properties**	**% Population Annoyed**	**% Population Highly annoyed**	**Receptor Type, Comments**
Major	49	2	10	3	Residential
	50	2	11	4	Residential
	51	3	12	4	Residential
	52	4	13	5	Residential
	53	9	15	5	Residential & 1 nursing home
	54	14	16	6	Residential
	55	14	18	6	Residential. 1 property to be acquired. 1 property to be demolished, 1 amenity area, 1 commercial
	56	14	19	7	Residential
	57	23	21	8	Residential, 1 property to be acquired
	58	18	22	9	Residential, 2 properties to be acquired
	59	16	24	9	Residential, 1 property to be acquired. 1 amenity area
	60	9	26	10	Residential, 1 property to be acquired
	61	4	27	11	Residential, 1 property to be demolished
	62	1	29	12	Commercial, building to be demolished

Locations with Major Change in Noise Levels - Opening Year – 2024					
Change in Noise Level, Impact Rating	**Calculated Noise Levels**	**No properties**	**% Population Annoyed**	**% Population Highly annoyed**	**Receptor Type, Comments**
	63	1	31	14	Residential, building not habitable

During the Opening Year, where a 'Major' change in noise levels has been determined in accordance with the DMRB short-term assessment table, absolute noise levels are calculated in the range of 49 to 61dB L_{den} (excluding properties being acquired or demolished as part of the proposed road development).

The majority of assessment locations are residential properties (high sensitivity) and all residential properties not being demolished in this category are below the TII design goal of 60dB L_{den} with the exception of 4 properties, 1 of which remains unoccupied and 3 of which are dominated by traffic along local roads.

There is one nursing home in this impact category (high sensitivity) with an absolute noise level calculated at 53dB L_{den} which is below a level whereby noise levels are considered intrusive or at a level that would cause any significant annoyance to the general population. There are two amenity areas of moderate sensitivity i.e. Menlo Castle and NUIG Sporting Campus with a calculated level of 55dB L_{den} and 59dB L_{den} respectively. The NUIG location is immediately adjacent to the alignment of the proposed road development. There is 1 commercial property (Dangan House) with a low sensitivity with a calculated noise level of 55dB $L_{den.}$

Table 17.19: Assessment of Absolute Noise Level Annoyance Levels relating to Moderate Change in Noise Levels – 2039

Locations with Moderate Change in Noise Levels - Opening Year – 2039					
Change in Noise Level, Impact Rating	Calculated Noise Levels	No properties	% Population Annoyed	% Population Highly annoyed	Receptor Type, Comments
Moderate	49	2	10	3	Residential
	50	2	11	4	Residential
	51	6	12	4	Residential
	52	1	13	5	Residential
	53	6	15	5	Residential & 1 nursing home
	54	7	16	6	Residential
	55	6	18	6	Residential
	56	11	19	7	Residential (1 property to be acquired, 1 to be demolished) 1

Locations with Moderate Change in Noise Levels - Opening Year – 2039					
Change in Noise Level, Impact Rating	Calculated Noise Levels	No properties	% Population Annoyed	% Population Highly annoyed	Receptor Type, Comments
					amenity area, 1 commercial
	57	9	21	8	Residential, 1 property to be acquired
	58	8	22	9	Residential, 1 amenity area
	59	13	24	9	Residential
	60	8	26	10	Residential, 1 amenity area
	61	7	27	11	Residential, 1 to be acquired
	62	3	29	12	Residential
	64	1	33	15	Building not habitable

Reference to **Tables 17.19** above indicates that where a 'Moderate' change in noise levels has been determined in accordance with the DMRB long-term assessment table for the design year, absolute noise levels are calculated in the range of 49 to 62dB L_{den} (excluding properties being acquired or demolished as part of the proposed road development).

The property types are predominately residential and hence are high sensitivity receptors. There are 10 residential properties with a residual noise level in the range of 61 to 62dB L_{den} (Refer to **Table 17.17** for specific receiver details). For all other residential properties where a moderate change in noise level is determined, the absolute noise level is below the 60dB L_{den} design goal.

There is one nursing home in this impact category (high sensitivity) with an absolute noise level calculated at 53dB L_{den}. There is one amenity area (Menlo Castle) of moderate sensitivity and 1 commercial property (Dangan House) with a low sensitivity, with a calculated level of 56dB $L_{den.}$ There are two assessment locations within the NUIG Sporting Campus (moderate sensitivity) with calculated noise levels in the range of 58 to 60dB $L_{den.}$ It should be noted, these locations are calculated in close proximity to the road alignment. Noise levels in this area reduce at the playing areas and amenity walking areas located further north and south of the proposed road alignment.

Table 17.20: Assessment of Absolute Noise Level Annoyance Levels relating to Major Change in Noise Levels – 2039

Locations with Major Change in Noise Levels - Opening Year – 2039					
Change in Noise Level, Impact Rating	**Calculated Noise Levels**	**No properties**	**% Population Annoyed**	**% Population Highly annoyed**	**Receptor Type, Comments**
Major	54	4	16	6	Residential
	55	6	18	6	Residential
	56	7	19	7	Residential
	57	8	21	8	Residential
	58	11	22	9	Residential, 1 property to be acquired
	59	10	24	9	Residential, 1 property to be acquired
	60	5	26	10	Residential, 1 property to be acquired
	61	1	27	11	Residential. Property to be demolished
	63	1	31	14	Commercial. Property to be demolished

During the design year, where a ‘Major’ change in noise levels has been determined in accordance with the DMRB long-term assessment table, absolute noise levels are calculated in the range of 54 to 60dB L_{den} (excluding properties being acquired or demolished as part of the proposed road development). All properties in this category which are not being acquired or demolished are residential and are all below the TII design goal of 60dB L_{den}.

Summary of Residual Impacts

Taking into account the proposed noise mitigation measures, the calculated residual noise levels, the increase in noise levels, and the absolute noise level under consideration, the impact of the residual noise impacts associated are determined as follows:

- Operational noise levels have been designed to not exceed the TII design goal of 60dB L_{den} at the majority of the noise sensitive locations along the proposed road development
- Absolute noise levels associated with both ‘Moderate’ and ‘Major’ changes in noise levels are in the range of 48 to 62dB L_{den}. The percentage of the population typically highly annoyed by road traffic noise in this range is 3 to 12% respectively. This represents a low percentage of the population likely to

experience high levels of annoyance when exposed to the range of noise levels under consideration

- Whilst a higher number of locations are determined to experience a ‘Major’ change in noise levels during the opening year, the absolute noise level under consideration are below a level that would pose high levels of annoyance to the typical population in accordance with published data
- During the design year, the number of properties determined to experience a ‘Major’ change in noise levels is significantly reduced compared to the opening year due to the threshold values for impact ratings in the long-term period
- Taking account of the factors above, it is considered that residual noise impacts across the full extent of the proposed road development are determined to be imperceptible to significant, with the majority of properties overall, experiencing an imperceptible to moderate impact

Comment on Schools Along the Proposed Road Development

There are two schools located in proximity to the proposed road development, St. James’ National School in Bushypark and Castlegar School off School Road. Both schools have been assessed in terms of their noise impacts. Calculated noise levels at St James’ National School are 56dB L_{den} taking account of noise mitigation in this area. This represents a minor increase above the pre-existing noise environment and is an acceptable external noise levels for school buildings.

Calculated noise levels at Castlegar school are made along the southern façade and rear facades facing the proposed road development. Taking account of the screening provided by the extensive cutting in this area, the proposed low noise road surface and noise barrier, residual noise levels are calculated in the range of 56 to 58dB L_{den}. Taking account of baseline noise levels measured at the school and adjacent properties along School Road, this represents a minor change in the noise environment and is an acceptable external noise levels for school buildings.

Reduction in Traffic Along Existing Road Network

The proposed road development will result in a reduction in traffic volumes along the existing road network, particularly along routes traversing Galway City Centre.

It is possible to determine the approximate change in noise levels between the Do Minimum and Do Something scenarios using the traffic volumes calculated for the wider road network within Galway City. Using the same formulae described in **Section 17.5.3.2**, the reduction in traffic noise levels along the existing road network across Galway City is calculated and presented in **Table 17.21**.

Table 17.21: Calculated Reduction in Traffic Noise Levels along Existing Road Network - 2039

Road Link	Do Minimum		Do Something		Estimated Reduction in Traffic Noise Level, dB
	AADT	% HGV	AADT	% HGV	
N6 South of Briarhill	31,459	7%	18,553	6%	-3
N6 Near Ballybrit Business Park	25,974	7%	15,440	5%	-3
N6 between N83 and R865	26,749	6%	18,599	3%	-3
N6 Between N84 and N83	20,691	5%	11,442	4%	-3
N6 East of Quincentenary Bridge	24,315	6%	23,059	5%	-1
N6 - On Quincentenary Bridge	34,546	7%	24,437	5%	-3
R338 at Westside Playing fields	14,061	5%	7,538	1%	-7
Western Distributor Road between Clybaun Road and R338	11,657	2%	7,975	1%	-3
Western Distributor Road between Clybaun Road and Ballymoneen Road	8,959	1%	7,153	0%	-2
R337 Kingston Road. Kingston	11,955	4%	7,097	0%	-6
R336 Salthill Road Upper Galway Golf Course.	11,677	2%	9,648	2%	-1
R336 Bearna Road. Bearna Woods	16,273	2%	4,321	0%	-9
R336. Bearna Road. Bearna. Creagan Bus Stop	12,666	3%	2,951	0%	-10
Boleybeg Road. Between Cappagh Road and Ballymoneen Road	1,937	1%	713	1%	-3
N59. Thomas Hynes Road. Between Hazel Park and Cherry Park	6,642	2%	5,121	0%	-4
N59. Upper Newcastle Road. Between R338 and Corrib Village	12,920	2%	10,810	0%	-4
N59. Barnacranny. Between Chesnut Lane and Circular Road	18,050	2%	14,687	0%	-4
N84. South of Ballindooley. Ballindooley Lough	14,298	6%	17,754	3%	-1
R338. Dublin Road. West of Junction with Coast Road.	18,606	8%	17,703	7%	-1
R338. Dublin Road. Between Renmore Road and Michael Collins Road	17,742	7%	17,005	5%	-1
R336. Tuam Road. Mervue Business Park	16,980	7%	13,146	6%	-2
Wolfe Tone Bridge	18,074	4%	14,613	4%	-1
O'Briens Bridge	9,725	4%	9,010	3%	-1
Salmon Weir Bridge	17,910	1%	14,644	2%	-1
Eglington Street	5,420	3%	4,728	2%	-2

Road Link	Do Minimum		Do Something		Estimated Reduction in Traffic Noise Level, dB
	AADT	% HGV	AADT	% HGV	
Cappagh Road - North of GCRR	548	0%	257	0%	-3
N6 East of Ballybrit	26,992	7%	17,179	4%	-3
N59 South of Link to Interchange	18,050	2%	14,687	0%	-4
Gort Na Bró South of Rahoon Road	2,927	0%	2,110	0%	-1
Western Distributor Road - East of Gort Na Bró	11,779	2%	8,065	1%	-3

Referring to **Table 17.21** the estimated reduction in traffic noise levels along the existing road network across Galway City is in the range of 1 to 10dB. The greatest reduction in noise levels will be experienced along sections of the R336, R337, R338 and the N59 Roads with estimated traffic noise reductions ranging between 4 and 10dB. There are extensive areas of high sensitive locations along and in proximity to these routes including high numbers of residential areas, educational buildings and hospitals which will therefore experience a moderate to major positive impact as a result of the proposed road development.

Referring the Galway City Noise Action Plan (2013 – 2018), sections of the N6, R336, R338, N84 and N59 which are identified as areas qualifying for noise management due to high traffic noise levels (>70dB L_{den} and > 57dB L_{night}) will experience a reduction in noise levels as a result of the proposed road development and hence will achieve part of the Noise Action Plan objectives.

The reduction in high volumes of traffic traversing the city centre will result in a positive moderate to major noise impact to an extensive number of noise sensitive properties along a large portion of the existing road network.

Night-Time Noise Levels

The TII guidelines do not prescribe any night-time noise limit values within its guidance document. The L_{den} parameter by its nature, however is a composite parameter relating to noise levels over day, evening and night-time periods. The 60dB L_{den} deign goal included in the TII documents for road projects therefore includes noise levels over all three periods.

The DMRB Volume 11 Section 3 Part 7 (2011), notes that night-time noise levels at or below 55dB L_{night} are not considered for impact rating. This is based on information contained in the WHO Night Noise Guidelines (2009) which sets an interim target level of 55dB L_{night} across Europe. The assessment notes that where locations exceed a night-time noise level of 55dB L_{night}, the impact rating relating to changes in the noise environment are assessed using the DMRB long-term assessment table.

The Galway City and Galway County Noise Action Plans both set an onset noise level of 57dB L_{night} for areas where noise management should be put forward for consideration.

Night-time noise levels are calculated as part of the L_{den} calculation procedure and are presented separately in **Appendix A.17.3** for each assessment location. There are a total of 33 properties included as part of this assessment which exceed a night-time noise level of 55dB L_{night}. All of these properties are along existing national and regional routes namely the N6, N83, N84 and N59 and R446. At 19 of these properties, night-time noise levels will be reduced as a result of the proposed road development and hence will experience a positive impact. At the remaining 14 properties, night-time noise levels are increased by 0.2 to 2.8dB L_{night} with an impact rating of negligible.

Specific comment in relation to night-time noise levels and associated health impacts are discussed in **Chapter 18, Human Beings, Health and Population**.

17.7.4 Cumulative Impacts

The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of other committed and proposed road developments below which have the potential to generate traffic volumes within the study area:

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Transport Strategy (GTS), which includes the following:
    - Investigation of prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway

Further details on the traffic modelling forecasts are set out in **Chapter 6, Traffic Assessment and Route Cross Section**.

The cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. During the Do-Nothing scenario, road traffic flows along the existing road network have been modelled and the cumulative traffic noise level calculated. For the modelled Do-Something scenarios, road traffic along the existing road network coupled with traffic along the proposed road development are combined to obtain a cumulative traffic noise level. The assessment takes account of any alignment alterations to the existing roads and junction and the re-distribution of traffic along the existing road network as a result of the proposed road development.

In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Table 17.13** and **Table 17.15**.

In relation to cumulative construction impacts, other committed or proposed construction projects have been reviewed in the vicinity of Galway City and County including the N59 Maam Cross to Oughterard Road Project (consented and pre-construction), N59 Moycullen Bypass (consented and pre-construction), M6(M17/M18) Motorway Service Area (pre-planning. All of these projects are set back at considerably distances from the proposed road development such that if under construction at the same time, no cumulative noise and vibration impacts would occur.

Whilst there is the potential to be other small local construction activities across the study area during the construction phase, for the purposes of this assessment it has been assumed that works associated with the proposed road development will be the dominant noise and vibration source at any one location.

17.8 Summary

An assessment relating to the potential noise and vibration impacts of the proposed road development has been determined for both the construction phase and the operational phase.

During the construction phase, the assessment has determined that noise impacts will be negative moderate short-term and in some instances negative significant and momentary depending on the activities involved. The use of best practice noise control measures, hours of operation, scheduling of works within appropriate time periods, strict construction noise limits and noise monitoring during this phase will ensure impacts are controlled to within the adopted criteria. Similarly, vibration impacts during the construction phase will be well controlled through the use of low impact equipment and adherence to strict limit values which will be subject to monitoring at the nearest sensitive buildings.

During the operational phase, noise levels will be increased at the majority of noise sensitive locations along the length of the proposed road development. Whilst noise levels of varying increases and impact magnitudes are calculated at the assessment locations, the incorporation of a low noise road surface and the use of noise barriers along the proposed roadside boundary will reduce noise levels to within the design goal of 60dB L_{den} or to the pre-existing Do Minimum noise levels at the majority of noise sensitive locations. Residual noise levels at a small number of locations will remain above the 60dB L_{den} design goal by 1 to 2dB. The assessment has concluded that changes in road traffic noise levels will be negligible to major in accordance with DMRB guidance. The overall noise impact at the assessment locations taking account of the change in the noise environment, the absolute noise levels under consideration and the typical population response to the absolute noise levels under consideration across the study area is determined to be imperceptible to significant, with the majority of properties overall experiencing a slight to moderate impact

Overall, noise levels will be increased at properties along the route of the proposed road development once operational and a change in the noise environment will occur. The proposed road development, however, has been designed to reduce operational noise levels to within national design guidelines through the incorporation of detailed noise mitigation measures. The number of properties along its route is relatively low compared to those within the city centre which are currently exposed to significantly higher noise levels from passing road traffic. The reduction in high volumes of traffic traversing the city centre will result in a moderate to major positive noise impact to an extensive number of noise sensitive properties along the existing road network.

17.9 References

BS 5228. (2009 +*A1 2014*) *Code of Practice for noise and vibration control of construction and open sites - Part 1: Noise.*

BS 5228. (2009+*A1 2014*) *Code of Practice for noise and vibration control of construction and open sites - Part 2: Vibration*.

BS 6472. (2008) *Guide to evaluation of human exposure in buildings - Part 2: Blasting.*

European Communities *Noise Emission by Equipment for Use Outdoors) Regulations*, 2001.

Design Manual for Roads and Bridges (DMRB). Volume 11 *Environmental assessment Section 3 environmental assessment techniques. Part 7 hD 213/11 – revision 1 – Noise and Vibration*.

EEA. 'Good Practice Guide on Noise Exposure and Potential Health Effects' (EEA Technical Report 11/2010).

EPA. (2006) *Environmental Management Guidelines - Environmental Management in the Extractive Industry (Non-Scheduled Minerals)*.

EPA. (2015) *Advice Notes for Preparing Environmental Impact Statements. Draft September 2015*.

EPA. (2015) *Revised Guidelines on the Information to be Contained with Environmental Impact Statements. Draft September 2015*.

EPA. (2017) *Guidelines on the information to be contained in environmental impact assessment reports (Draft August 2017).*

Galway City Council. *Noise Action Plan* 2013 – 2018.

Galway County Council. *Noise Action Plan* 2013 – 2018.

International Standard ISO 1996: 2007: *Acoustics – Description, measurement and assessment of environmental noise*.

Transport Infrastructure Ireland. (TII). (2004) *Guidelines for the Treatment of Noise and Vibration in National Road Schemes*.

TII. (2014) *Good Practice Guide for the Treatment of Noise during the Planning of National Road Schemes*.

UK`s Department of Transport. (1988) *Calculation of Road Traffic Noise (CRTN)*.

WHO Night Noise Guidelines for Europe (NNG 2009)

18 Human Beings, Population and Human Health

18.1 Introduction

This chapter of the EIAR consists of an impact appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, under the heading of Human Beings, Population and Human Health. This is a broad ranging topic which *"covers the existence, activities and health of people, usually considering people as groups or 'populations'"* (EPA 2015)[1].

Aspects examined in this chapter primarily relate to impacts from the proposed road development on socio-economic activities and on local community health.

Aspects related to socio-economic activities include journey patterns, amenity and community severance, business, tourism and employment, and use of the Irish language. The Irish language is addressed separately in various sections of this chapter. Other aspects relevant to human beings such as natural amenity, built and natural heritage, ecosystem services, material assets and nuisance are dealt with in the following chapters:

- Chapter 7, Construction Activities
- Chapter 8, Biodiversity
- Chapter 9, Soils and Geology
- Chapter 10, Hydrogeology
- Chapter 11, Hydrology
- Chapter 12, Landscape and Visual
- Chapter 13, Archaeological, Architectural and Cultural Heritage
- Chapter 14, Material Assets Agriculture
- Chapter 15, Material Assets Non-Agriculture
- Chapter 16, Air Quality and Climate
- Chapter 17, Noise and Vibration

Human health impacts are primarily considered through an assessment of the environmental pathways by which health can be affected such as air, noise, water or soil. Therefore, the health assessment relies on the assessments in the following chapters and draws on the findings as necessary to examine whether the effects arising from any identified impacts may have a health impact and to ensure that the effects which may have a health impact are fully considered:

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[1] Extracted from the Advice Notes for Preparing Environmental Impact Statements (EPA draft September 2015) which have not been updated since

- **Chapter 9, Soils and Geology** to identify if there are any areas of contaminated soils
- **Chapter 10, Hydrogeology** to identify areas with any potential impacts on groundwater
- **Chapter 11, Hydrology** and **Appendix A.11.1** to identify areas with any potential impacts on surface water and areas of flood risk
- **Chapter 16, Air Quality and Climate** to identify the predicted air quality values adjacent to the proposed road development
- **Chapter 17, Noise and Vibration** to identify the predicted noise levels at properties adjacent to the proposed road development

The health assessment also considers psychological effects, health improvement and improvement to services. Other aspects, such as changes in traffic flows which are dealt with in **Chapter 6, Traffic Assessment and Route Cross-Section**, have also been considered in this chapter in relation to the assessment of Socio-economic and Health impacts to ensure that the effects of these issues on human beings, population and human health have been addressed.

This chapter initially sets out the methodology (**Section 18.2**), describes the receiving environment (**Section 18.3**) and summarises the main characteristics of the proposed road development which are of relevance for human beings, population and human health (**Section 18.4**). The evaluation of impacts of the proposed road development on human beings, population and human health are described (**Section 18.5**). Measures are proposed to mitigate these impacts (**Section 18.6**) and residual impacts are described (**Section 18.7**). The chapter concludes with a summary (**Section 18.8**) and reference section (**Section 18.9**).

To inform the human beings, population and human health impact appraisal, this chapter has utilised the information gathered during the constraints and route selection studies for the proposed road development. Submissions received as part of the extensive public consultation carried out in respect of the project were assessed and design changes made to minimise the potential impacts on human beings and properties as part of the design phase. These submissions also informed the assessment undertaken for this chapter. **Sections 4.17, 6.5.11** and **7.6.11** of the **Route Selection Report** considered the human beings and population constraints within the scheme study area and compared the potential impacts on human beings and population of the proposed route options. These sections of the Route Selection Report contributed to the design of the proposed road development.

This chapter should be read in conjunction with **Figures 18.1.001**, **18.1.002** and **18.1.101** to **18.1.114** which illustrate the location of community facilities such as schools, hospitals, hotels relative to the proposed road development.

18.2 Methodology

18.2.1 Introduction

This assessment has been prepared in accordance with the relevant guidelines listed in **Section 18.2.2.1** below. Data has been collected primarily through a review of relevant documents listed in **Section 18.2.2.1** below and information gathered through the extensive public consultation detailed in **Chapter 1, Introduction** and mapping provided by the design team. This data was supported by site visits and local discussions with residents, businesses, schools and representatives of other community facilities. Furthermore, a Language Impact Assessment (LIA) for the proposed road development has been undertaken, the results of which are included in **Section 18.5.6**. A literature review on the potential impacts of roads on human health has also been carried out and is detailed in **Section 18.2.5.7** of this EIAR.

Aspects examined in this chapter primarily relate to impacts from the proposed road development on socio-economic activities and on local community health. These two themes are discussed together in some sections of this chapter but separately in other sections where appropriate.

18.2.2 Relevant Guidelines, Data Sources and Consultations

18.2.2.1 Relevant Guidelines

This assessment has been prepared having regard to the following guidelines:

- Guidelines on the Information to be contained in Environmental Impact Statements (EPA 2002)
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA 2003)
- Advice Notes for Preparing Environmental Impact Statements (EPA draft September 2015)
- Revised Guidelines on the Information to be Contained in Environmental Impact Statements (EPA, draft September 2015)
- Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, draft August 2017)
- Guidelines for treatment of tourism in an Environmental Impact Statement (Fáilte Ireland, 2011)
- European Commission Guidance (2003) Implementation of Directive 2001/42 on the assessment of the effects of certain plans and programmes on the environment
- Environmental Impact Assessment of Projects – Guidance on the preparation of the Environmental Impact Assessment Report (European Commission 2017)
- The World Health Organisation (WHO) Night time Noise Guidelines for Europe

- Health Impact Assessment Resource and Tool Compilation (US EPA 2016)
- World Health Organisation Guidelines for Community Noise (1999)
- Health in Environmental Impact Assessment - A Primer for a Proportionate Approach (IEMA 2017)
- Health Impact Assessment (Institute of Public Health Ireland 2009)

18.2.2.2 Data Sources and Consultations

An assessment of the potential impacts on human beings, population and human health requires an understanding of the community which is built up through background research, site visits, and discussions with members of the local community and the findings of the assessment of the environmental factors (pathways) through which health could be affected such as air, noise, water, soils, property acquisition or demolition and traffic volumes. The potential impacts of the proposed road development on human beings, population and human health is then assessed against this background data.

Background data has been collected for the proposed road development by means of:

- Primary data sources (e.g. demographic data from Census 2016, Census 2011 and Census 2006 as produced by the Central Statistics Office)
- Maps of the surrounding area, including Ordnance Survey 1:50,000 maps and aerial mapping
- A review of the design of the proposed road development and its potential impacts on material assets non-agriculture
- A review of secondary sources including the Galway County Development Plan 2015-2021 as varied and the proposed Variation No. 2 to the Galway County Development Plan, the Galway City Development Plan 2017-2023 as varied, the Bearna Local Area Plan as amended, the Gaeltacht Local Area Plan 2008-2014 as extended, the Ardaun Local Area Plan 2018-2024 and reports Galway City Council or Galway County Council such as the Socio Economic Statement of County Galway (2015), the Galway City Local Economic and Community Plan 2015-2021, and the various websites relating to economic developments, tourism, amenity and recreation e.g. www.galwaychamber.com and www.galwaytourism.ie
- Observation of local settlement and travel patterns and identification of community facilities
- Public consultation process which included discussions with local organisations and residents and with relevant statutory bodies. Over 950 individual property owner meetings, including many home visits, took place between the design team and property owners and the concerns expressed during these meetings were taken on board and fully informed the human beings, population and health assessment. The full details of this public consultation process are set out in **Chapter 1, Introduction**

- A literature review on the potential impacts of roads on human health. This review has focused on reviewing scientific evidence of the potential impacts of roads on human health and is detailed in the relevant sections below
- Collating the results of the assessment of the environmental factors (pathways) through which health could be affected such as air, noise, water, soils and traffic volumes, which are based upon reference to accepted standards/guidelines/limits for the protection of human health
- In this chapter, an assessment is performed by considering health in its broader aspects. As well as considering the protection of health, this chapter also considers opportunities for health improvements and access to services. The data used to assess opportunities for health improvements and access to services included information gathering during the extensive public consultations including a meeting with University Hospital Galway and data extracted from the traffic model to identify accessibility to services
- The traffic model was also used to quantify the health impacts in terms of difference in people walking or cycling and the level of accessibility and social inclusion with the proposed road development and the full set of measures identified by the GTS complete
- For the Irish Language assessment, consultation with Údarás na Gaeltachta and feedback from the public consultation was utilised
- A ‘human beings, population and health’ workshop also took place on the 8 June 2017 with the design team, noise, air, socio-economic, landscape and visual and health experts in attendance. The purpose of this workshop was to discuss any significant effects of the construction and operation of the proposed road development on human beings, population and health and the findings of this workshop informed this chapter

18.2.2.3 Study Area

The study area for the socio-economic appraisal covers the lands within and adjacent to the proposed development boundary in addition to areas where changes in traffic volumes are predicted. The study area extends from Na Foraí Maola, west of Bearna Village to the existing N6 to the east at Coolagh and includes a rural/semi suburban landscape populated with individual dwelling and community facilities.

The study area for the Irish language appraisal covers the lands within and adjacent to the proposed development boundary as for the socio-economic appraisal but also includes the Galway Gaeltacht.

The study area in relation to the protection of human health appraisal varies depending on the emission type and its extent, for example, impacts arising from noise, air, water and soil vary with the precise distance depending on the particular emission, its concentration and other dispersion factors. Refer to the **Chapter 9, Soils and Geology**, **Chapter 10, Hydrogeology**, **Chapter 11, Hydrology**, **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration** for details of the study areas of the particular emission types (soil, water, air and noise).

18.2.3 Impact Assessment Methodology - Socio-Economics

This section presents the methodology and criteria used in the socio-economic assessment of impacts on human beings and population, and is followed by the impact assessment methodology used in the Irish language assessment in **Section 18.2.4** and health assessment in **Section 18.2.5**.

The purpose of the socio-economic appraisal is to identify the potential significant impacts as they can affect local people and users of the proposed road development during both the construction and operational phases, along with the likely economic impacts at both local and regional level. Socio-economic impacts on human being's due to a development of this type fall into four key categories, namely:

1. <u>Journey characteristics:</u> accessibility and connectivity, including potential impacts on journey time, journey time reliability and travel patterns
2. <u>Amenity:</u>
    a. Journey amenity: Impacts on journey amenity arising from pedestrian/cyclist proximity to traffic, volume of traffic, frequency of congestion, pedestrian and cycle facilities, noise, air quality and changes in the visual environment (as discussed in respective chapters of this EIAR) as they relate to the pleasantness of the environment for walking, cycling or driving
    b. General amenity: Impacts due to any effect that the proposed road development may have on residential quality of life, amenity or recreation facilities due to the same factors together with changes in environmental quality or facilities for amenity
3. <u>Community severance:</u> with regard to the use of community facilities, particularly those used by older people, children or other vulnerable groups
4. <u>Economic</u>: an evaluation of the proposed road development in the context of economic development, tourism and employment

In addition, relative to many other road developments, the proposed road development will involve a high number of residential, and some commercial, demolitions and acquisitions, due to the dispersed pattern of development within the study area. These potential impacts are addressed specifically under the category of general amenity.

Impacts are compared between the Do-Nothing and the Do-Something scenarios and arise from direct, indirect, secondary and cumulative effects on environmental conditions. Impacts can be positive, neutral or negative. The significance of an impact/effect is described as *Imperceptible*, *Not Significant*, *Slight*, *Moderate*, *Significant*, *Very Significant* or *Profound*. It usually follows that the significance of an impact depends, among other considerations, on:

- The location and character of the local environment
- The sensitivity of the local population and its capacity to absorb change
- The nature of the environmental effect
- The timing and duration of an effect

- The scale or extent of the effect in terms of area or population affected
- The magnitude (duration and frequency) of an effect
- The probability of an effect's occurrence

The impacts may be short term, medium term or long term. Construction impacts relevant to the socio-economic assessment are, by their nature, temporary in nature, although the impact of demolitions can have a prolonged effect on communities that remain.

In line with best practice the socio-economic assessment generally addresses effects at a community level rather than for individuals or identifiable properties, although impacts for small communities are assessed where these may consist of a handful of houses or families, impacts on individual businesses are discussed where these are especially significant. The rationale for applying a particular level of significance to an impact as it would affect the worst hit subset of the population is summarised in **Tables 18.13** and **18.14**. The tables include:

1. The nature of an effect
2. Location and the population subgroup affected
3. The current situation
4. The potential impact due to the proposed road development
5. Impact significance
6. Impact duration (i.e. temporary, short, medium or long term)
7. Receptor extent
8. Proposed mitigation
9. The residual impact

Receptor extent qualifies the preceding assessment of significance by identifying the number of receptor types, i.e. people or businesses, likely to be affected as an approximate proportion of the local population or the total number of businesses. Receptor extent is assessed qualitatively as: few; medium; many; or very many. For instance, an impact may be significant for a particular population subset, but the number of people impacted could be few in number. The table also describes the mitigation proposed and the residual significance of the impact.

18.2.3.1 Journey Characteristics

The assessment of journey times and patterns is inevitably dependent on precisely where an individual journey originates and ends, when it is undertaken (e.g. within or outside peak hours) and by whom it is undertaken, i.e. by drivers, cyclists, users of public transport or pedestrians, including individuals whose transport options may be restricted. The impact varies for each journey, but typical journeys to popular destinations can often be identified. Potential impacts have been assessed in accordance with the significance criteria outlined in **Table 18.1** with positive impacts resulting from a decrease in journey length or time and negative impacts resulting from an increase in journey length or time.

Table 18.1: Criteria used in the assessment of changes in Journey Length or Duration

Impact level	Significance criteria
Imperceptible	No noticeable change to present journeys length or duration
Not significant	An effect which can cause noticeable change, but without significantly extending (or shortening) journey length or duration, or changing journey habits
Slight	Slight improvement to journeys length or duration where impact is positive. Some inconvenience where impact is negative. Some likelihood of changes in journey habits
Moderate	Moderate reduction in journey length or durations where impact is positive, moderate increase where impact is negative. Greater likelihood of changes in journey habits
Significant	Much shorter journey length or duration where impact is positive, much longer increase where impact is negative. High likelihood of changes in journey habits
Very significant	Considerably shorter journey length or duration where impact is positive, considerably longer increase where impact is negative. High likelihood of changes in journey habits
Profound	An approximate doubling (or halving) in typical journey length or duration sufficient to cause marked change in behaviour of a sizeable proportion of population

Journey length refers to the distance associated with a particular journey, whilst duration is the time taken to make the journey. The average walking speed for pedestrians is taken to be 5km/hr (3km/hr for vulnerable groups). International studies suggest that the average urban cycle speed is between 12-20km/hr. Impacts on journey amenity and community severance are addressed separately in the sections below, although there are obvious interactions between each of these categories and with economic impacts. In addition, new transport facilities can improve accessibility of places which were formerly awkward to reach or improve connectivity between home and workplaces, community facilities and between parts of a city or region. Improved connectivity can have implications for choice of transport mode, for land use and economic development.

18.2.3.2 Amenity

Journey amenity

The assessment of journey amenity uses the same significance categories as before and is supported by cross-reference where necessary with chapters on traffic, noise or visual impacts. The level of traffic on a road, the proximity and separation of footpaths and cycle-paths, the nature of any crossings/junctions to be negotiated, the legibility of a journey (including signage), visual intrusions (including sightlines) and perceived and actual safety, are amongst the factors relevant to the assessment of journey amenity, as are the number and types of people affected. The principal concern is with pedestrians or cyclists, but journey amenity impacts also apply to drivers, for example due to safety anxiety associated with the crossings of major roads. Such journeys could involve sensitive population subgroups such as older drivers or school children as passengers. There are interactions too with the assessment of journey characteristics and community severance.

General amenity

The key criterion in relation to general amenity is community wellbeing, including social sustainability. Direct effects on communities due, for example, to loss of community facilities such as amenity space, natural areas or opportunities to interact with others, can impact on community wellbeing or community interaction. Indirect effects may result from changes in environmental quality, for instance, from noise or visual intrusion and are cross-referenced where applicable with relevant chapters of the EIAR. Impact levels are defined in **Table 18.2** below.

Table 18.2: Criteria used in the assessment of amenity impacts

Impact Level	Significance Criteria
Imperceptible	No noticeable change in the character of the environment
Not significant	An effect which can cause noticeable changes in the character of the environment, but without significant consequences for the community's well-being, amenity or health
Slight	A small impact on community wellbeing can be attributed to the proposed road development
Moderate	A moderate impact on the community wellbeing can be attributed to the proposed road development
Significant	An effect which has the potential to impact on community wellbeing such as to affect people's behaviour and quality of life
Very significant	An effect which has the potential to substantially impact on community wellbeing such as to affect most people's behaviour and quality of life
Profound	Effects of a scale to significantly impact on community wellbeing to an extent that people's behaviour or quality of life is substantially changed, for example where significant health issues arise or where people may wish to relocate

Demolitions and acquisitions

Demolitions or acquisitions of residential properties are subject to financial compensation, but can have a significant impact on the householders involved. In addition, there can be significant impacts on communities or neighbours left behind, especially where the number of demolitions or acquisitions represents a high proportion of the total number of households. The impact definitions applied to the category of general amenity have been applied to the subject of demolitions and acquisitions in this chapter. The potential health impacts as a result of demolitions or acquisitions is assessed in **Section 18.5.5**.

18.2.3.3 Community Severance

Severance is a typical impact of a road. Its effect is to discourage community interaction and occurs where access to community facilities or between neighbourhoods is impeded by a lengthening of journey time or by the physical barrier of a road (for example, high traffic volumes or perimeter fencing). Social severance can occur due to restrictions on people's accessibility, but also where communities become identified by their containment within road boundaries. This can include the psychological effect of traffic or safety concerns as barriers to social interaction. Social severance can also occur for busy roads such as motorways even where access is available. On the other hand, relief from existing severance may be provided by a new road where traffic volumes or speed are moderated, by the inclusion of crossing facilities in the design, or through the presence of overbridges or underpasses.

The definition of severance is not precise. It depends on the location of community facilities, the level of use of facilities, the time of day or duration when traffic conditions are experienced, the sensitivity of the population affected and the geographical spread of the community. Children, the elderly, the mobility impaired and people without access to a private car would be amongst those most affected by community severance and any corresponding loss of neighbourhood interaction.

Sensitive receptors are identified specifically where they comprise a high proportion of pedestrian journeys or where specific amenities are associated with these groups. Sensitive groups can include young and older population cohorts, the mobility impaired and people at risk of social isolation. Relevant community facilities include schools, surgeries, hospitals, churches, post offices, shops, sports facilities and centres of social activity.

New Severance

New severance is a negative impact generated and occurs whenever a barrier is created between people and community facilities. The barrier could take the form of a new road, fencing, additional traffic or the need to detour from a current traveling route. **Table 18.3** below provides examples of how new severance can be defined. The criteria are specific to pedestrians, although severance will apply also to cyclists and potentially to local vehicle journeys too, particularly for some sensitive population sub-groups. Quantitative criteria have not been included in the table as impact definitions may vary depending on the nature of road trips and crossings (i.e. by car or pedestrian). Similarly, the introduction of crossing facilities could reduce severance even where traffic levels are increased.

Table 18.3: Criteria used in the assessment of New/Increased Severance

Impact level	Significance criteria
Imperceptible	Journey patterns maintained
Not significant	Noticeable effects on connectivity, but without significant consequences for journey patterns
Slight	Present journey patterns likely to be maintained, albeit with some hindrance to movement
Moderate	Some residents, including children and elderly people, are likely to encounter severance. For others, journeys will be longer or less attractive
Significant	Many residents, including children and elderly people, are likely to encounter significant severance which could discourage them from making particular journeys

Impact level	Significance criteria
Very significant	Most residents, including children and elderly people, are likely to encounter significant severance which will be sufficient to induce a reorganisation of their activities or cause them to make less frequent trips to nearby neighbourhoods or to make less use of particular community facilities
Profound	People are likely to be deterred from making trips to an extent that includes permanent loss of access or a change in the location of centres of activity

Relief from Severance

Relief from severance is a positive impact which is defined in relation to existing severance. Relief from severance could follow from a transference of traffic from an existing road, including heavy goods vehicles (HGVs), from improvements in road design or sightlines, or from the introduction of crossing facilities. The Annual Average Daily Traffic (AADT) data was taken from the traffic model for the proposed road development. However, the degree of relief from severance depends on the context in which this change occurs including the existing absolute volume of road traffic, but also the speed of traffic and number of crossings by pedestrians, cyclists or others. **Table 18.4** provides a guide to criteria used in the assessment of relief from severance. It should be noted that a relief from severance is a positive impact and therefore the table reflects the positive impact levels, increasing from imperceptible to profoundly positive. Where the assessment varies from these definitions due to the context in which the relief occurs, the reasons for the variance are discussed. There is also the potential for interactions with Journey Amenity, in that there are implications for real and perceived safety.

Table 18.4: Criteria used in the assessment of Relief from Severance

Impact level	Significance criteria
Imperceptible	No noticeable consequences for journey patterns
Not significant	Noticeable effects on connectivity, i.e. <10% reduction in daily traffic levels (AADT), but without significant consequences for journey patterns
Slight	10-30% reduction in traffic levels (AADT) or some reduction in severance
Moderate	31-50% reduction in traffic levels (AADT) or a reduction in severance sufficient to encourage some new journeys by foot or bicycle
Significant	51-70% reduction in traffic levels (AADT) or a reduction in severance sufficient to allow residents to make more frequent journeys to community facilities by foot or bicycle
Very significant	71-90% reduction in traffic levels (AADT) or a very significant reduction in severance sufficient to allow most residents to make more frequent journeys to particular community facilities by foot or bicycle
Profound	More than 90% reduction in traffic levels (AADT) or reductions in severance such as to provide new access to community facilities or to cause a very significant increase in pedestrian or cycle journeys

18.2.3.4 Economic

General

Economic and employment impacts occur at both the local and regional scale and can be either positive or negative. A development can have positive effects for ancillary businesses or for employment or, alternatively, have negative effects for other businesses. Changes in access or connectivity, as discussed under the category of journey characteristics, can have significant effects on business or investment. Impacts include changes in turnover or in access to business opportunities. Effects could impact on individual companies or the wider community, for example where a number of businesses are affected or where the retail or business environment of a town is impacted. Impact levels are defined in **Table 18.5** below.

Tourism

Tourism makes a significant contribution to the Irish economy, to local economies and to regional development. It provides opportunities for business development, growth and innovation with Small and Medium Sized Enterprises (SMEs) being well-represented in the sector. Consequently, it is also important for employment and is relatively labour intensive compared with other industrial sectors. Interactions between journey characteristics, journey amenity or the nature of destinations used for amenity, can have an impact on tourism and businesses and employment in this sector. Tourist numbers can be affected by either a lengthening or shortening of journeys and reduced or improved connectivity with tourism destinations. Changes in both journey characteristics and amenity can impact on the decision to stop or overnight at particular locations. Changes to sites of cultural or natural heritage value can either discourage or encourage tourists to stop or to continue with their journey or, in extreme cases, to travel at all. Tourists include international visitors as well as visitors from other regions of Ireland.

Table 18.5: Criteria used in the assessment of Economic Impacts

Impact level	Significance criteria
Imperceptible	No noticeable economic impacts
Not significant	An effect which causes noticeable changes in the character of the environment, but without noticeable consequences for the local economy, businesses or employment
Slight	A small effect (positive or negative) on the business environment can be attributed to the proposed road development
Moderate	A moderate effect (positive of negative) on the business environment can be identified
Significant	An effect (positive or negative) that has the potential to impact on business performance or to influence the location decisions of new business
Very significant	An effect (positive or negative) that has the potential to substantially impact on business performance or to influence the location decisions of new business
Profound	Effects of a scale to significantly impact (positively or negatively) on the performance of a major business or several businesses. Where these businesses are important local employers there is the possibility of major impacts for the general prosperity of the local area or region

18.2.4 Impact Assessment Methodology – Irish Language

The purpose of the Irish Language appraisal is to identify the potential significant impacts, if any, of the proposed road development during both the construction and operational phases on the Irish Language.

The Irish Language appraisal is based on:

- inspection of the associated environmental studies and project documentation
- consideration of national legislation and policy documents and the Galway County and City Gaeltacht Development Plans and local area plans (LAPs) including the Gaeltacht LAP as extended and Bearna LAP as amended
- review of relevant submissions made during the public consultations and consultation with Údarás na Gaeltachta
- consideration of previous case work experience

This assessment has been prepared with due regard to the guidelines on the preparation of environmental impact assessment report published by the EPA in 2017 and the preparation of environmental impact statements published by the EPA in 2002, 2003 and 2015.

18.2.5 Impact Assessment Methodology – Human Health

This section sets out the methodology that was used in order to assess the impact of the proposed road development on health.

18.2.5.1 Guidance on the methodology for assessing human health in EIA

The recitals to the 1985 and 2011 EIA Directives refer to "human health" and include "Human Beings" as the corresponding environmental factor. The 2014 EIA Directive (2014/52/EU) changes this factor to "Population and Human Health". However, no specific guidance on the meaning of the term Human Health has been issued in the context of Directive 2014/52/EU. In addition, no specific guidance on the assessment of human health in the context of EIA has been issued to date.

The 2017 draft EPA guidelines on the information to be contained in Environmental Impact Assessment Reports note that "*while no specific guidance on the meaning of the term Human Health has been issued in the context of Directive 2014/52/EU, the same term was used in the SEA Directive (2001/42/EC)*". The Commission's SEA Implementation Guidance (section 5.26) states "*The notion of human health should be considered in the context of the other issues mentioned in paragraph (f) and thus environmentally related health issues such as exposure to traffic noise or air pollutants are obvious aspects to study*". (Paragraph (f) (of Annex I of the SEA Directive) lists the environmental factors including soils, water, landscape, air etc.).

The 2017 draft EPA guidelines note that the above health assessment approach is consistent with the approach set out in the 2002 EPA Guidelines where health was considered through assessment of the environmental pathways through which it could be affected, such as air, water or soil:

"*The evaluation of effects on these pathways is carried out by reference to accepted standards (usually international) of safety in dose, exposure or risk. These standards are in turn based upon medical and scientific investigation of the direct effects on health of the individual substance, effect or risk. This practice of reliance upon limits, doses and thresholds for environmental pathways, such as air, water or soil, provides robust and reliable health protectors [protection criteria] for analysis relating to the environment*".

The 2017 draft EPA guidelines also note that in an EIAR, "*the assessment of impacts on population & human health should refer to the assessments of those factors under which human health effects might occur, as addressed elsewhere in the EIAR e.g. under the environmental factors of air, water, soil etc. and that "assessment of other health & safety issues are carried out under other EU Directives, as relevant. These may include reports prepared under the Integrated Pollution Prevention and Control, Industrial Emissions, Waste Framework, Landfill, Strategic Environmental Assessment, Seveso III, Floods or Nuclear Safety Directives. In keeping with the requirement of the amended Directive, an EIAR should take account of the results of such assessments without duplicating them*".

The Institute for Environmental Management and Assessment (IEMA) in the UK issued a discussion document in 2017 *Health in Environmental Impact Assessment*

- *A Primer for a Proportionate Approach*, which it describes as a primer for discussion on what a proportionate assessment of the impacts on health should be in EIA and is a useful document when considering what can and should be assessed in the context of EIA. Regard has been had to the general approach advocated in this document when compiling this chapter.

One of the messages in the IEMA document in terms of assessing health in EIA, is that there should be a greater emphasis on health outcomes, (that is the potential effects on human health), rather than simply the health determinants, (that is the agents or emissions which could have the potential to have health effects). The IEMA document noted that in EIA, there has previously been a strong focus on just the agents or emission levels (e.g. dust) rather than focussing on the effects of these agents/emission levels on human health. This change in emphasis does not mean a complete change in practice. For example, measurement and modelling of dust levels continues to be an essential part of the health assessment.

The IEMA document notes that "*public health is defined as the science and art of promoting and protecting health and well-being, preventing ill-health and prolonging life through the organised efforts of society and has three domains of practice: health protection, health improvement and improving services*". The IEMA document suggests that these three domains should be considered in the assessment of health in EIA. Examples of health protection issues to be considered could include issues such as chemicals, radiation, health hazards, emergency response and infectious diseases whilst health improvement issues could include lifestyles, inequalities, housing, community and employment. Examples of improving services issues could include service planning, equity and efficiencies.

The World Health Organization (WHO) defined health in its broader sense in its 1948 constitution as "*a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity"*. Therefore, whilst the EPA guidance is useful in terms of health protection, for a more holistic assessment as per the IEMA document, it is also worthwhile to look at broader health effects in terms of opportunities for improvement of health and for improvement of access to services. While it is important to do this, it is also important not to attribute every conceivable event as being a health effect. To further rely on the WHO definition, a health effect would be something that would have a material impact on somebody's physical mental and social well-being be that positive or negative.

Health Impact Assessment versus Environmental Impact Assessment

The IEMA document notes that Health Impact Assessment (HIA) and EIA are separate processes and that whilst a HIA can inform EIA practice in relation to human health, a HIA alone will not necessarily meet the EIA human health requirement. HIA is not routinely carried out for major infrastructure schemes in Ireland.

Guidance for performing Health Impact Assessment (HIA)'s was issued by the Institute of Public Health in Ireland in 2009. There are however considerable difficulties in performing a HIA as outlined by the Institute of Public Health for a project such as a road development. Not least of these is the difficulty of getting baseline health data. It is quite difficult due to patient confidentiality and other reasons to accurately determine levels of even relatively common medical conditions in a relatively defined population that might be affected by a road project. Qualitative and quantitative baseline health data is a vitally important part of the appraisal section of the HIA. In the absence of an accurate baseline it is very difficult to assess qualitative and quantitative changes that might occur. One could use more generalised data that might exist for larger areas such as a city or county but these would be at most an estimate of the local baseline and not accurate enough to allow for meaningful interpretation. Therefore, a standalone HIA is not considered the most appropriate for this assessment.

The IEMA document notes that the WHO provides an overview of health in different types of impact assessment[2] and presents the WHO perspective on the relationship of HIA to other types of impact assessment as follows:

"The health sector, by crafting and promoting HIA, can be regarded as contributing to fragmentation among impact assessments. Given the value of impact assessments from a societal perspective, this is a risk not to be taken lightly ... The need … and justification for separate HIA cannot automatically be derived from the universally accepted significance of health; rather, it should be demonstrated whether and how HIA offers a comparative advantage in terms of societal benefits …

Health issues can, and need to, be included [in impact assessment] irrespective of levels of integration. At the same time, from a civic society perspective, it would be unacceptable for HIA to weaken other impact assessments. A prudent attitude suggests optimizing the coverage of health along all three avenues:

- *better consideration of health in existing impact assessments other than HIA;*
- *dedicated HIA; and*
- *integrated forms of impact assessment*

It is clear therefore that even the WHO does not support a stand-alone HIA unless it could be demonstrated to be of advantage over the EIAR. It is for these reasons that this health assessment is part of the EIAR and there is no stand-alone HIA.

It is therefore important to note that this assessment on human health is part of an overall EIAR rather than a stand-alone HIA. The HIA is defined as a combination of procedures, methods and tools that systematically judges the potential, and sometimes unintended, effects of a policy, plan, programme or project on both the health of a population and the distribution of those effects within the population, whilst the health assessment in the context of EIA focuses the attention of the assessment on likely significant effects, i.e. on effects that are deemed likely to occur and, if they were to occur, would be expected to be significant (as per the requirements of the EIA Directive). Conducting an HIA will not necessarily meet the EIA population and human health requirement.

Therefore, *health protection, health improvement and improving services* are all considered in this chapter of the EIAR. The methodology for assessing health

2 World Health Organization Regional Office for Europe. Health in impact assessments: opportunities not to be missed. 2014

protection, health improvement and improving access to services is considered further in **Sections 18.2.5.3**, **18.2.5.4** and **18.2.5.5** respectively of this EIAR.

18.2.5.2 Literature Review

A literature review on the potential impacts of roads on human health has been carried out. This section presents the results of that literature review which informed the methodology used for human health assessment.

One of the first areas in the literature review to consider is the health determinants relevant to the proposed road development – that is the agents or emissions which could have the potential to have health effects. Health outcomes – that is the potential effects on human health arising from those health determinants are then considered.

The environmental factors (pathways) through which health could be affected by a road development both during construction and operational phases include:

- Noise and Vibration – for example potential exposure of people to noise emissions from vehicles and construction activities
- Air - for example potential exposure of people to dust and air emissions from vehicles and construction activities
- Water – for example potential exposure of people to changes in water quality (surface and ground water) or changes in water flows – flood risk
- Soils – for example potential exposure of people to contaminated land

The health outcomes arising from such emissions are discussed further below.

In addition, the impacts of the proposed road development on psychological health and also health improvements and improvements to services have been included in the literature review below. These topics also fall under the area of "Wellness".

The last fifteen years in Ireland has seen the development of the modern motorway network between the major urban centres as well as relief roads in urban areas. The literature review included a review of any published data of reported health effects from either the construction or operation of these roads. Using a "PubMed[3]" search, key words such as "Health Effects Roads Ireland" found that there were no published studies in peer reviewed literature. There was however a significant tranche of literature from outside Ireland and in particular in relation to emissions to air and noise. The vast majority of the studies deal with potential emissions from operational roads with a particular emphasis on Noise, Particulate Matter (including PM_{10} and $PM_{2.5}$) as well as other air pollutants such as NO_2 and SO_2 amongst others. The literature is clear that these are the major hazards with the potential for human health effects. The literature is also strongly consistent with a Dose response effect as presented in **Table 18.6** below with regard to noise and air emissions - the lower the dose the lower the effect. Health based standards[4] such as WHO and EU

[3] PubMed is a search engine accessing primarily the MEDLINE database of references and abstracts on life sciences and biomedical topics.

[4] The term standards in this instance covers guidelines for example noise guidelines as such standard are not currently available.

standards incorporate literature evidence in the setting of these standards. In essence there is little evidence of significant health effects from air and noise emissions when these standards are not exceeded. It is important to note that these standards are set to protect vulnerable subsections of the population including its most vulnerable members which include children and persons with disabilities and, accordingly, will necessarily protect the more robust subsections. Other emissions such as water and soil can be an issue if there is potential contamination to water or soil or an enhanced flood risk. Again, there is little evidence of significant health effects from water and soil emissions when these standards are not exceeded.

The health assessment in this EIAR considers the results of technical assessments for environmental factors listed above which are detailed in **Chapter 9, Soils and Geology**, **Chapter 10, Hydrogeology**, **Chapter 11, Hydrology**, **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration** and their proposed mitigation measures to establish any potential health hazard directly attributed to what is proposed.

These assessments use standards (such as air quality standards) in order to identify whether significant impacts will arise or not. Again, as noted above, the health standards such as those set by the WHO are primarily intended to protect the vulnerable subsections of the population and, accordingly, will necessarily protect the more robust subsections. The standards are set at levels for which there will be no significant health effects, but do not exclude each and every effect, i.e. slight or moderate health effects are possible even below the levels at which health based standards would apply.

These health based standards are discussed further below in relation to the various environmental pathways but it is also appropriate to understand the principle behind the setting of such standards.

Noise

Noise is measured using the standard decibel scale (dBA). The “A” represents a weighting that mimics human hearing. It is important to note that because the decibel is a logarithmic scale i.e. a non-linear scale, the figure can be somewhat confusing. Essentially, an increase by 3dB means a doubling of the sound intensity in energy terms.

The human ear however does not perceive this degree of increase in volume. Normally a 10dB increase in noise level equates to a subjective doubling in audible sound. Very few noise sources are constant. A series of noise events can be averaged over any given period of time using the equivalent continuous sound level (Leq). Leq is the method of averaging recommended in industry and environmental assessments and in guidelines issued by, for example, the World Health Organization.

It is normally assumed that noise inside a building with the windows open, will be at least an estimated 15dB less than that outside. With windows closed, noise levels are reduced further inside, up to in excess of 35dB, depending on the building fabric. The actual attenuation varies depending on the type of building, size of the windows and other factors.

It should be noted that the assessment for this EIA Report relates to environmental exposure to noise. Undoubtedly those with the highest noise exposure will be those working on the construction of the proposed road development. Legislation is in place for control of work place noise and is policed by the Health and Safety Authority.

A Europe-wide study by Fritschi, 2011[5]) and another paper by Hellmuth, 2012[6], published by WHO demonstrate a significant burden of adverse health impacts associated with environmental noise exposure, drawing from earlier WHO publications summarising health evidence and recommending guidelines for community noise exposure. A review of noise exposure across Europe in 2014 by the European Environment Agency (EEA) likewise recommends and applies metrics for various health outcomes. In general terms, increasing noise in communities is associated with adverse health outcomes and vice versa. The nature and the severity of these outcomes is further discussed below.

The potential health impacts due to noise include:

- Noise-Induced Hearing Impairment
- Interference with Speech Communication
- Disturbance at schools
- Sleep Disturbance
- Hypertension and Cardiovascular Disease

Noise-Induced Hearing Impairment

Hearing impairment is typically defined as an increase in the threshold of hearing. It is assessed by threshold audiometry. It only occurs however above a certain noise level. Data from the International Standards Organisation (ISO) and WHO states that Noise Induced Hearing Loss will not occur at noise levels below 70dB no matter how long the exposure continues.

Interference with Speech Communication

Noise interference can interfere with speech comprehension. These may include problems with concentration, fatigue, uncertainty and lack of self-confidence, irritation, misunderstandings, decreased working capacity, problems in human relations, and a number of stress reactions.

Particularly vulnerable to these types of effects are the hearing impaired, the elderly, children in the process of learning, and individuals who are not familiar with the spoken language. Sensitive communication takes place indoors for the majority of the time and as noted above, the average noise attenuation of being inside a building with the windows open is conservatively estimated to be 15dB.

[5] Fritschi, L. et al., 2011. Burden of disease from environmental noise, Copenhagen: WHO Regional Office for Europe

6 Hellmuth, T., Classen, T., Kim, R. & Kephalopolous, S., 2012. Methodological guidance for estimating the burden of disease from environmental noise, Copenhagen: WHO Regional Office for Europe

Disturbance at schools

There are several studies on the effect of environmental noise on education. However most of these relate to airport noise and to a lesser extent traffic noise. From the literature review undertaken, school learning may be the factor most affected by environmental noise.

The RANCH study was one of the largest studies performed on this matter in Europe and was published in the Lancet in 2005. While showing little new data, it suggests a small effect on reading comprehension in 9 to 10 year old primary school children. It also stated "Neither aircraft noise nor traffic noise affected sustained attention, self-reported health, or overall mental health." It was surprising that the study suggested significantly improved memory function in children exposed to high levels of traffic noise. This appears intuitively difficult to understand, but certainly does not suggest that there is the opposite effect. Based on this literature review, disturbance at schools will not be a significant issue.

Sleep Disturbance

Sleep disturbance is considered to be a major environmental noise effect on human health. It is however estimated that 80-90% of the reported cases of sleep disturbance in noisy environments are for reasons other than noise originating outdoors. Understanding of the impact of noise exposure on sleep stems mainly from experimental research in controlled environments.

Field studies conducted with people in their normal living situations are scarce. However most of the more recent field research on sleep disturbance has been conducted for aircraft noise.

Sensitive groups include the elderly, shift workers, persons especially vulnerable to physical or mental disorders and other individuals with sleeping difficulties.

There is evidence that habituation to night-time noise events occurs, and that noise-induced awakening decreases with increasing number of sound exposures per night. Studies have also shown that the frequency of noise-induced awakenings decreases for at least the first eight consecutive nights with people becoming accustomed to the noise thereafter (Journal Behavioural Sleep Medicine, 2007). In summary people get used to the noise and the potential for interference with sleep diminishes.

As stated above most of the published research is related to aircraft noise but in a published study (Babish, 2006) which studied some 23,000 people, the authors concluded that at the same average night time noise-exposure level, aircraft noise is associated with more self-reported sleep disturbance than road traffic, and road traffic noise is associated with more sleep disturbance than railways.

People also sleep during the daytime, for example shift workers, and instances where ambient noise levels are much greater during the day it is therefore less likely that an additional noise source will have a significant effect to those who try to sleep during day time.

Hypertension and Cardiovascular Disease

A number of studies have postulated a link between environmental noise and hypertension and also cardiovascular disease. There is somewhat more evidence in relation to airport noise rather than noise due to road traffic. Some of the studies, particularly in relation to noise due to road traffic, have problems due to potential confounders[7]. One of the issues was trying to differentiate whether effects may be due to air pollution rather than noise. Some more recent studies have suggested that noise may have an independent effect. The extent of the effect is difficult to determine but it is clear that it is only at higher levels of environmental noise that any measurable effect is likely to occur.

Regarding road noise specifically, several meta-analyses of cardiovascular disease have been published by W. Babisch. These date from 2006 to 2014 and show evidence to provide a risk ratio for all ischaemic heart disease (IHD), also known as coronary heart disease (CHD) risk. A meta-analysis published by Vienneau in 2015, used many of the same studies to establish an IHD risk ratio that was used in the 2014 European Environment Agency quantification of noise health impacts across Europe. A limited number of studies of stroke risk associated with environmental noise exposure have also been published by Houthuijis.

These postulated links have been considered by expert bodies such as the WHO when they set their noise guidelines and in particular the night time noise guidelines.

In 2009 the WHO issued Night Noise Guidelines for Europe which explore the effects of night time noise. It stated that in the two European countries studied (Switzerland and The Netherlands) that almost 50% of the population are exposed to night time noise in excess of 45dB L_{night}.

These guidelines quote some health effects at quite low night time levels and proposed an ideal noise level of 40dB L_{night} as measured outside residences. They do however accept that this is essentially unachievable in the foreseeable future and therefore proposes an interim value of 55dB L_{night} outside instead.

It should also be stated that the effects detected at lower night time levels (below 55dB L_{night}) are relatively benign in terms of health effects such as increased mobility (tossing and turning) while asleep. More significant health effects are only linked to much higher noise levels, usually in excess of 70dB L_{night}.

The WHO night noise guidelines refer to L_{night} parameter which relates specifically to noise levels over the night-time period. The NRA Guidelines on the Treatment of Noise and Vibration and quoted in **Chapter 17, Noise and Vibration** sets a design goal in terms of a composite 24 hour parameter, the L_{den}. Whilst the L_{den} includes for night-time noise, direct comparison of the two parameters is not possible as they relate to different averaging time periods. The results of the noise assessment were discussed by the author of this chapter and an understanding of the difference in units and its implications for the results was obtained.

[7] In statistics, a confounder (also confounding variable or confounding factor) is a variable that influences both the dependent variable and independent variable causing a spurious association.

In most urban environs one would expect many areas to have noise levels at or above 55dB L_{night} and Galway is no different. In this context any assessment of potential impacts must take into account the baseline or existing noise levels.

It is important to note that whilst the WHO Guidelines are used in assessing potential health impacts, they can at times be misinterpreted. They are not, and were never intended to be, considered as a threshold. For example, the difference between a property experiencing a night time noise level of 54dB and another property experiencing a night time noise level of 55.1dB would be imperceptible for individuals living there and differences in health status would also be imperceptible.

The WHO Guidelines are guidelines for protection of health in communities. In terms of potential impacts on health, night time noise is far less important and does not merit being considered in the same way as other factors such as diet, exercise, cigarette smoking and genetics. The slight increase or decrease in night-time noise that might occur on individual residences would be so small as to be unmeasurable in terms of health effects. Therefore, in assessing night time noise in the context of the WHO Guidelines, it should only be in the context of overall noise levels in the community rather than the increase or decrease at an individual residence or clusters of residences. Whilst noise levels are often quoted with respect to potential effects on health and they are used in the significance assessment, it should be noted that the differences in significance between the different levels are relative rather than absolute.

Summary Noise

In terms of the health effects of environmental noise there is some limited evidence of effects on blood pressure, cardiovascular risk, school performance and in relation to sleep disturbance. Any effects demonstrated are more likely at higher noise levels. Many effects are only demonstrated with ambient noise in excess of 70dB.

Vibration

Vibration has the potential to have health effects when perceptible. These could include for example sleep disturbance. Another issue which is sometimes described is infrasound. The latter is sound but at a frequency so low that it is not audible to the human ear. If at high levels it may be perceived as vibration. These effects, in relation to vibration and infrasound, however only occur when the levels are high and perceptible to human beings for example an underground train.

Air Quality

Vehicles with internal combustion engines emit air pollutions, including particular matter, carbon monoxide, nitrogen oxides and a variety of hydrocarbons. Previously, lead compounds were added to petrol and lead emissions were a major issue but the sale of leaded petrol has been banned for many years. In the last few years in Ireland, partly because of tax driven reasons, there has been a switch in the type of internal combustion engines in cars from primarily petrol to primarily diesel cars in newer vehicles. Emissions would be broadly similar. However, there are some differences and in particular there is a higher level of particulate emissions from diesel cars. Nitrogen oxides and hydrocarbons can oxidise oxygen in the air to ozone if exposed to high levels of sunlight. While this is problematic in some countries, it is less likely to be an issue in the Galway area for reasons outlined further below.

The following components of air emissions of motor vehicles were considered for the health assessment:

- carbon monoxide
- other products of combustion
- fine particulates

Carbon Monoxide

Carbon monoxide is formed by incomplete combustion of fuels such as petrol and diesel. It can be absorbed into the blood stream and reduce the oxygen carrying capacity of blood. It is present in all forms of combustion. High levels of carbon monoxide exposure are associated with increased hospital admissions, cardiovascular disease and mortality.

Products of combustion

Nitrogen dioxide, and oxides of Nitrogen in general, directly affects the lungs. It is also gas produced during fuel combustion and impairs the lungs immune defence mechanism. When contacted with water which would line the lungs, it forms an acid to essentially burn the airways. There can be an increased severity of asthmatic attacks, etc. due to high levels of exposure to nitrogen dioxide.

Fine particles

Fine particles include PM_{10}, i.e. particulate matter less than 10 micrograms in diameter but also in more recent time, more emphasis has been made on smaller particles, again including $PM_{2.5}$, i.e. less than 2.5 microns, PM_1 and even nanoparticles which are smaller particles again. These have been known to exacerbate respiratory conditions such as bronchitis and pneumonia and there is increased mortality with higher levels.

Particulate emissions have received attention in recent years given increasing evidence of their health effects. Indeed, there have been calls to ban diesel vehicles in larger cities because of potential adverse effects. However, when assessing the human health impacts of the proposed road development, one must consider the Do-Nothing scenario would lead to those vehicles continuing to go through congested city centre routes with slow average speeds giving the potential for greater emissions. Overall therefore the proposed road development may have potential benefits regarding particles compared to the Do-Nothing scenario. This is discussed further in **Section 18.6** of this EIA Report.

Appropriate Standards

The starting point in selecting the appropriate standard to apply is EU directives which had been set down. In Ireland, these are monitored by the EPA. The current applicable directive is the Clean Air for Europe (CAFÉ) Directive.

The following table shows the limit or target values specified by the directive that set down limits for specific air pollutants. The directive covers:

- Sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter (PM_{10} and $PM_{2.5}$) and lead
- Carbon monoxide and benzene
- Ozone
- Arsenic, Cadmium, Nickel and Benzo(a)pyrene

Table 18.6: Limit values of CAFE Directive 2008/50/EC

Pollutant	Limit Value Objective	Averaging Period	Limit Value ug/m3	Limit Value ppb	Basis of Application of the Limit Value	Limit Value Attainment Date
SO_2	Protection of human health	1 hour	350	132	Not to be exceeded more than 24 times in a calendar year	1 Jan 2005
SO_2	Protection of human health	24 hours	125	47	Not to be exceeded more than 3 times in a calendar year	1 Jan 2005
NO_2	Protection of human health	1 hour	200	105	Not to be exceeded more than 18 times in a calendar year	1 Jan 2010
NO_2	Protection of human health	calendar year	40	21	Annual mean	1 Jan 2010
PM_{10}	Protection of human health	24 hours	50		Not to be exceeded more than 35 times in a calendar year	1 Jan 2005
PM_{10}	Protection of human health	calendar year	40		Annual mean	1 Jan 2005
$PM_{2.5}$ - Stage 1	Protection of human health	calendar year	25		Annual mean	1 Jan 2015
$PM_{2.5}$ - Stage 2	Protection of human health	calendar year	20		Annual mean	1 Jan 2020
Lead	Protection of human health	calendar year	0.5		Annual mean	1 Jan 2005

Pollutant	Limit Value Objective	Averaging Period	Limit Value ug/m3	Limit Value ppb	Basis of Application of the Limit Value	Limit Value Attainment Date
Carbon Monoxide	Protection of human health	8 hours	10,000	8620	Not to be exceeded	1 Jan 2005
Benzene	Protection of human health	calendar year	5	1.5	Annual mean	1 Jan 2010

As discussed previously, air quality standards are set to protect the vulnerable such as those with respiratory illnesses, the old and infirm. Slightly higher levels of oxides of nitrogen above the standards may have no effect on the vast majority of the population but may be significant for the vulnerable. Hence the human health impact assessment has relied on compliance with the Air Quality Standards to determine whether significant impacts will arise on human health or not. The standards used in **Chapter 16, Air Quality and Climate** include the *Air Quality Standards Regulations 2011*, which incorporate *European Commission Directive 2008/50/EC* which has set limit values for the pollutants SO_2, NO_2, PM_{10}, benzene and CO. The C*ouncil Directive 2008/50/EC* combines the previous *Air Quality Framework Directive (96/62/EC)* and its subsequent daughter directives (including *1999/30/EC* and *2000/69/EC*). Provisions were also made for the inclusion of new ambient limit values relating to $PM_{2.5}$. These are clearly appropriate and robust standards. The table above shows that the levels are set primarily for the protection of human health. Therefore, provided these levels are not exceeded one can be confident that there will be no adverse effect on human health due to air emissions.

Potential Health Impacts from Air

In 2010, the Health Effect Institute (HEI) Panel in the US, in a study partially funded by the US EPA on the Effects of Traffic-Related Air Pollution, concluded that exposure to air pollutants specifically from roads is likely to be associated with all-cause mortality[8], cardiovascular disease incidence and mortality, and reduced lung function, albeit with weaker evidence (due to fewer and smaller studies) than the wider air pollution health evidence base.

The WHO published a review in 2005 of the health effects of transport-related air pollution which concluded that health effects include increased cardiopulmonary mortality risk and respiratory morbidity risk.

Since 2013, the International Agency for Research on Cancer (IARC) defines diesel engine exhaust as carcinogenic to humans. Petrol engine exhaust is classified by IARC as possibly carcinogenic, as there is inadequate evidence to form a firmer conclusion.

A relatively recent article by Chen et Al published in the Lancet in early 2017 showed a small (7%) increase in the incidence of dementia in those living less than 50 meters from major roads but no increase in the incidence of Multiple Sclerosis or Parkinsons disease. The authors postulated that increased levels of $PM_{2.5}$ and

[8] This is mortality from all causes e.g. cancer, heart, lung etc.

NO_2 may be associated factors. However, there were important limitations on the study as the study was based in Ontaria, Canada where major roads would include very busy highways and trunk roads. Perhaps the most significant criticism of the study was that the authors could not account for socio-economic effects. Socio-economic effects are related to the incidence of dementia. Therefore, if the individuals living within 50 metres of major roads in Ontario were of lower socio-economic status than those living further away this might explain the relatively small increase in the occurrence of dementia in this study. Overall while further studies are recommended one can draw relatively little from this one study.

While there are some difficulties making comparisons between the impact of road building in say China, far more relevant information can be gleaned with similar projects within Ireland while being conscious of international published data. This is due to the fact that the baseline environment in densely populated counties such as China, which currently includes polluted air quality in its baseline, is not comparable to that of Ireland and in particular Galway.

The 2014 publication from the OECD The Cost of Air Pollution, The Health Impacts of Road Transports points out that while the health impacts of air pollution in western countries is decreasing, that it is increasing in countries like China and India. It is more important for us in Ireland to consider the data from this country and similar countries.

While it is now 13 years old, an important document in Ireland was the Health Impacts of Transport, a Review published in March 2005 by the Institute of Public Health in Ireland. This remains the most recent publication from this body on this subject.

The document reviews the elements of health impacts of transport. It originated as part of the transport HIA in Ballyfermot organised by the Eastern Regional Health Authority and proceeds from the Institute's strategic objective to strengthen the capacity of those working for public health.

In the Executive Summary they stated:

"the effect of air quality on human health has been extensively researched and expert opinion is available in this area. Currently, evidence is strongest for air pollution as a cause for short-term health problems in certain groups such as the elderly and those with underlying health problems such as heart or lung disease. Longer term health impacts are suspected to result from certain components of air pollution. However, it has been difficult to ascribe a cause and effect with certainty. Traffic is a leading source of air pollution and any issues which would reduce traffic volume can have potential benefits to health by improving air quality. Vehicle speeds is also a factor warranting consideration. Low average speeds such as those on congested routes are less efficient in the use of fuel and result in greater pollution emissions."

It can be concluded that the principal of moving traffic to a road with higher average speeds has actually a potential benefit on health.

It is important in these areas to consider the baseline environment. The EPA Air Quality Index shows that the air quality in both Galway City and County is very good. There are multiple reasons for this. One is Galway's geographical location on the edge of the Atlantic Ocean exposed to prevailing winds which predominantly blow air pollutions away from the centres population. There have also been very good controls with regard to potential sources of pollution in the Galway area. This was further supported by the site specific air quality monitoring undertaken for the proposed road development. Refer to **Chapter 16, Air Quality and Climate**.

There is no history of heavy industry emitting high levels of pollutions for example. The major sources of industry currently operating in Galway include medical device companies with very low emissions. It is against this background air quality that any emission would occur. These are detailed further in **Chapter 16, Air Quality and Climate**.

Water

Accessibility to high quality clean water is obviously very important contributor to human health. In Ireland these are regulated by the European Union (drinking water) Regulations 2014. These regulations impose duties on Irish Water and local authorities in relation to the sampling and recording of water quality. There are strict standards in relation to the quality of water in relation to its chemical content as well as microbiological aspects. Provided the standards are observed one can be confident that there will be no adverse effect on human health due to effects on water quality.

Flooding also has potential for human health effects. Apart from the economic impacts of flooding, particularly of repeated flooding in certain areas, individuals who have their homes and residences flooded can be subject to very significant psychological impacts. Financial loss can occur particularly in areas which previously experienced flooding and were no longer insured. This loss can relate to the actual damage to the properties caused by the flooding but also the potential loss in value of the property. These can be associated with increased levels of anxiety and even depression. Flooding can also be a potential source for the spread of disease. This made the spread by vermin or alternatively flooding the sewers and septic tanks. When considering the potential health effects of the proposed road development in relation to flooding, it is important to consider if the risk of flooding is increased or decreased or indeed unaffected by the proposed road development.

Soils

<u>Contamination of Land</u>

If a project has the capacity to contaminate land this also has the potential for human health effects. This contamination could for example arise if previously buried contaminated material is unearthed during the construction process. Examples of this might include an unidentified landfill, previous industrial contamination or indeed naturally occurring sources of contamination. Contaminated land could in turn affect health either by direct contact, either people living and working on the land itself or for example children playing on the land. Some contaminants may be concentrated in food grown in the land and this is another manner in which contaminated land could have a health effect.

Radon

Radon is a naturally occurring radioactive gas that originates from the decay of uranium in rocks and soils. It is colourless, odourless and tasteless and can only be measured using special equipment. When radon surfaces in the open air, it is quickly diluted to harmless concentrations, but when it enters an enclosed space, such as a house or other building, it can sometimes accumulate to unacceptably high concentrations. Radon decays to form tiny radioactive particles, some of which remain suspended in the air. When inhaled into the lungs these particles give a radiation dose that may damage cells in the lung and eventually lead to lung cancer.

It is only when radon has potential to build up in buildings that are inhabited by human beings that the health risk occurs. Indeed, these buildings due to heating or otherwise can in certain areas draw in radon from the ground as warm air rises within the buildings. If radon is found at high levels in buildings one of the most effective remedies is to create a sump which creates its own negative pressure and draws the radon away from entering the building. More information on this can be found on the EPA website[9].

Psychological

In the planning process, potential adverse effects on psychological health are often mentioned, for example, anxiety and stress experienced by those whose homes are to be unfortunately compulsory acquired or those whom will experience a change in the environment in which they live.

The community will also experience annoyance from the temporary impacts of traffic management and other effects during the construction phase. As against this there is the potential reduction in annoyance amongst road users in the operational phase where there are reduced journey times. Annoyance however, is not in itself a health effect.

For virtually every proposal for any road development there are concerns about potential adverse effects on a person’s overall psychological well-being. This is somewhat a more difficult matter to assess as there are no direct measurements one can use. While one can give great detail in predicting for example noise emissions one cannot use the same scientific certainty in predicting psychological impacts. It is not possible to use a standards-based approach for example.

There are various degrees of psychological impact and these can be both positive and negative. There can be a positive impact, whereby people may look forward to better transport. There can also be adverse effects of varying degrees. At the lower end of this impact might be annoyance where somebody is annoyed by for example, outside noise, dust depositing or temporary traffic delays associated with construction of the roads. This is not a medical impact as such. If someone develops a psychological illness such as anxiety or depression this would be a medical impact.

Construction by its very nature is transient but it is expected that construction activities will cause some annoyance such as from road diversions and temporary

[9] http://www.epa.ie/radon/getinformed/

road closures. The potential effects are minimised by use of appropriate traffic management and avoidance of extended night time closures. There has been a considerable amount of road construction in Ireland over the last few decades. However, there is no documented evidence from these projects to link adverse outcomes with psychological health in Ireland.

Health Improvements

The proposed road development has the potential to provide opportunities for health improvements.

Employment and income are among the most significant determinants of long-term health, influencing a range of factors including the quality of housing, education, diet, lifestyle, coping skills, access to services and social networks. Many epidemiological studies consistently show better health outcomes are associated with higher socio-economic status.

Consequently, poor economic circumstances can influence health throughout life, where communities subject to socio-economic deprivation are more likely to suffer from morbidity, injury, mental anxiety, depression and tend to suffer from higher rates of premature death than those less deprived. One of the most reliable methods to improve health within a community is to raise it socio-economic status.

Projects that have the potential to support regeneration, reduce unemployment and improve socio-economic circumstance, could contribute to improving the health and wellbeing of socio-economically deprived communities.

In social health terms, economic development also brings the opportunity for reducing inequities in society. Long-term unemployment for example is detrimental to the individual, family and society. It has potential to transfer across generations so that families where the head of household is long term unemployed are themselves far more likely to become or stay unemployed. This has potential to create and sustain social inequities. The economic development opportunities provided by the proposed road development have the potential to create more employment and reduce the risk of long-term unemployment. This in turn can lead to greater opportunities for equity in society.

Improvement of Access to Services

Studies show that recreational activities can have a positive impact on a person’s wellbeing and their health.

A study by Lyon et Al[10] from 2004 showed a much improved survival rate from out-of-hospital cardiac arrests was strongly influenced by reduced response times for emergency services. The ability for emergency services such as ambulances to rapidly access emergency situations therefore has the ability to save lives.

Improving access to cinemas, parks, retail and other recreational activities will therefore make it easier for people to undertake recreational activities. Improved

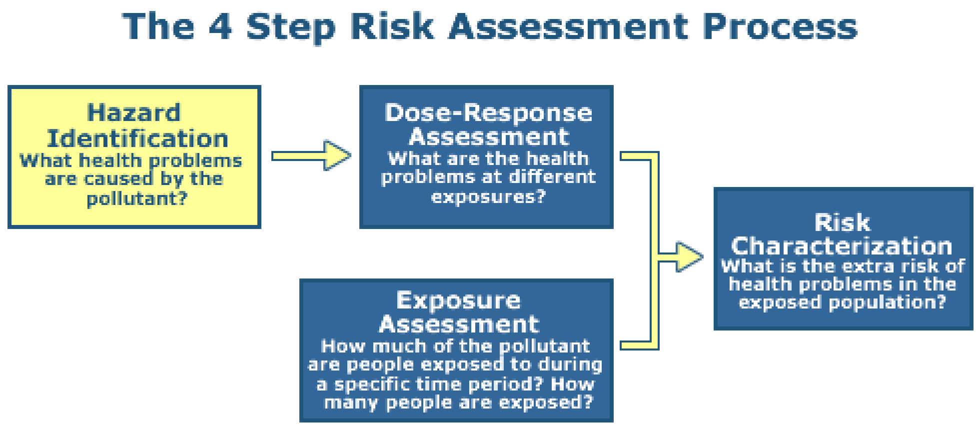
[10] Emerg Med J. 2004 Sep;21(5):619-24| Lyon RM1, Cobbe SM, Bradley JM, Grubb NR.

access to medical services will also have added benefits to a person's health as will access to education facilities as outlined above in the Health Improvement section.

18.2.5.3 Health Protection

The assessment of human health for the proposed road development, in terms of health protection, follows the approach set out in the EPA guidelines and in the European Commission's SEA Implementation Guidance. It is also similar in nature to the US EPA guidance. Human Health protection is considered through the assessment of the environmental factors (pathways) through which health could be affected such as air, noise, water and soils. The US EPA guidance includes a four step approach which is represented graphically in **Plate 18.1** below.

Plate 18.1: Human Risk Assessment



The potential noise, air, soils and water impacts which could affect human health were identified (Hazard Identification), the scale of these potential impacts (Dose-Response Assessment) and their duration (Exposure Assessment) were assessed and the significance of the potential impact on human health determined (Risk Characterisation).

When using a recognised Health Based Standard, the dose-response assessment is actually included in the standard. In other words, the authorities or expert committees which recommended the level of the standard will have taken into account the health problems at the different exposure levels and set the level within the standard to prevent these problems from occurring.

18.2.5.4 Health Improvement

Projects that have the potential to support regeneration, reduce unemployment and improve socio-economic circumstance, could contribute to improving the health and wellbeing of socio-economically deprived communities.

The assessment of human health for the proposed road development, in terms of health improvement, includes an assessment on how the proposed road development would impact on the socio-economics of the community.

18.2.5.5 Improvement of access to services

Improving access to services such as hospitals or recreational facilities will have an impact on the health of a community. Therefore, the assessment of human health for the proposed road development includes an assessment on whether or not the proposed road development will improve accesses to these services.

18.2.5.6 Significance of Health Impacts

There is a difficulty in assigning levels of significance to human health impacts. In medicine, as in all science, the concept of statistical significance is used. This involves attaching a value to significance, often expressed as a percentage level of confidence in the data. Confidence measures of 95% or even 99% are often used to measure levels of certainty or changes that are not due to chance alone.

This is a valid approach for the study of the impacts on a *population*, but does not absolutely exclude a response on an *individual*. However, it is difficult to assign levels of significance to individual human health impacts without detailed information about that individual. Thus, the significance of health effects are assessed on a group or community basis rather than on an individual basis. There is such a variability in human response that one could never identify all possible individual effects and so, in accordance with the guidance referred to above, it is considered to be more appropriate to assess the significance of health effects at a population level. The significance criteria for the assessment of the health of communities are therefore as outlined in **Table 18.7** below.

Table 18.7: Criteria Used in the Assessment of Community Health Protection Impacts

Impact Level	Significance Criteria
Imperceptible	No significant human health impacts are apparent
Slight	A small impact on reported symptoms but no change in health status can be attributed to the proposed road development
Moderate	A moderate impact on health status but no change in morbidity or mortality can be attributed to the proposed road development
Significant	The proposed road development has the potential to impact on health status with an associated change in morbidity
Very Significant	The proposed road development has the potential to impact on the health status of groups of people
Profound	The proposed road development has the potential to impact on the health status of communities

Asthma can be used as an example when using these criteria:

- An Imperceptible impact would be one with no measurable effect on asthma
- A Slight impact might be a temporary increase in symptoms but no change in the severity of the underlying condition or treatment required

- A Moderate impact might be an increasing use of inhalers attributable to the proposed road development but no change in underlying condition and no effect on the vast majority of asthmatics
- A Significant effect might be an individual becoming asthmatic or an individual's asthma becoming measurably more severe as a result of the proposed road development
- A Very significant effect might be a group of individuals becoming asthmatic or their asthma becoming measurably more severe as a result of the proposed road development
- A Profound effect might be a measurable increase in the incidence or severity of asthma in a community as a result of the proposed road development

18.3 Receiving Environment

18.3.1 Context

Galway City and its environs sits within the 4.5km[11] distance between the Lough Corrib and Galway Bay and is divided by the River Corrib with the built and natural environment and residential areas located on both sides of the river. The proposed road development skirts the city and majority of lands zoned for development. The baseline environment is represented by the semi-rural/urban fringe of Galway City and for the most part the landscape is dominated by low intensity grazing and uncultivated, undulating lands and bog and areas zoned for and built residential, commercial, and industrial and amenity development. However, given the built environmental, the linear development of the city with housing along every road radiating out of the city and the unavoidable proximity to residential areas, the proposed road development will unfortunately and unavoidably result in a number of property demolitions and community impacts.

Preliminary demographic data is available from Census 2016 (July 2016) on the population of Galway City and its environs. The Galway City Development Plan 2017-2023 draws on the population projections prepared for the Regional Planning Guidelines 2010-2022. In line with the National Spatial Strategy 2002-2020, it aims to concentrate population in the city with sufficient zoned land capacity to meet the needs of a population of 98,700 (36,286 households) by 2022. As of 2016, the Central Statistics Office (CSO) Census recorded a population of 78,668 for Galway City, an increase of 4.2% on the preceding figure for 2011 and 8.6% on 2006. The number of households also grew by around 4.1%. The figures demonstrate that the population has increased significantly in recent years despite the effect of the economic recession of 2008-2011. The population is, however, unlikely to grow at a rapid enough rate to meet the original projections of the Regional Planning Guidelines. Similarly, population projections in the Galway County Development Plan 2015-2021 also rely on the existing Regional Planning Guidelines. The County Development Plan proposes concentrating development in the hub town of Tuam, the Galway Gateway and the Strategic Economic Corridor to the east of Galway City between Oranmore and Attymon. Population growth will involve demand for

[11] Distance measured from south shore of Lough Corrib to Spanish Arch at Galway Docks

residential development and an increased pressure on the existing transport infrastructure.

Residential development has tended to occur on a largely west-east spine. Both the Galway City Development Plan and the Galway County Development Plan envisage an eastward extension of the city towards the area covered by the Ardaun LAP 2018-2024 to the east of Doughiska between the R339 Monivea Road and the R446 Doughiska Road. The development plans acknowledge the potential pressure that this new growth will place on existing transport infrastructure into the city and the need to integrate land use and transportation. A need for consolidation or regeneration within selected neighbourhoods is identified in the plans.

Residential development is more scattered within the urban fringe, often along minor roads and especially north of Bearna. There are distinct and established communities in addition to those listed in the data from the CSO below. Amongst others, these include Bearna, Na Foraí Maola, Troscaigh, An Chloch Scoilte, Cappagh, Ballymoneen, Keeraun, Mincloon, Dangan, Menlough, Ballindooley, Ballinfoyle, Castlegar, Parkmore, Doughiska and Coolagh.

Table 18.8: Population Galway City and County

	2016	2011	2006	2002
Galway City	78,668	75,529	72,414	65,832
Rest of County Galway	179,390	175124	159,256	143,245
Total County Galway	258,058	250,653	231,670	209,077

Table 18.9 indicates the population of each Electoral Division (ED) in the wider Galway area as recorded at the time of the 2016 Census. The table reveals modest percentage increases in population with some of the larger increases having been experienced in the suburban area of Ballybaan and the village of Bearna. Some more established areas such as Dangan have experienced an increase in population as compared to a reduction in the last Census period.

The extents of the Galway Gaeltacht area can be seen in **Figures 18.1.01** and **18.1.02**. Population figures for the Galway Gaeltacht to the west and north of the city are included in **Table 18.9** as these areas will be better connected by the proposed road development. Relative to several of the suburban and urban/rural fringe EDs, these figures reveal rather small population increases for the areas west of the city along the R336 as far as Rossaveel (Ros an Mhil) with the exception of Na Forbacha closer to the city where the population grew by 7.9%. The Gaeltacht is an area that is currently rather difficult to access from the east side of Galway City and the rest of the country, although growth potential here is somewhat restricted by the confinement to a narrow strip between the sea and blanket bog to the immediate north. The population growth has been greater in the Gaeltacht area along the N59 Moycullen Road between the city and Oughterard.

Table 18.9: Population Electoral Divisions

Electoral Division	Population 2016	Population 2011	Percent change	Population Density (persons per km²)
Galway Gaeltacht				
27054 Cil Chuimin (Kilcummin)	1314	1315	-0.1%	23.9
27061 Saileama	1453	1448	0.3%	21.2
27055 Cill Aithnin	1044	1000	4.4%	14.3
27063 An Spidéal	1443	1450	-0.5%	40.9
27051 Na Forbacha	1415	1312	7.9%	47.5
27159 Oughterard	2636	2604	1.2%	21.8
27162 Wormhole	2376	2315	2.6%	38.2
27062 Sliabh an Aonaigh	763	763	0%	13.2
27065 Tulaigh Mhic Aodhain	2075	1985	4.5%	68.4
27059 Maigh Cuillinn	2142	2008	6.7%	74.0
Galway Urban Rural fringe				
27044 Bearna (Barna Rural)	3727	3630	2.7%	156.4
27052 Galway Rural (part)[12]	149	126	18.3%	63.5
Galway suburbs				
26003 Bearna (Barna)	15185	14384	5.6%	2131.0
26015 Rahoon	3076	3009	2.2%	615.3
26006 Dangan	4132	3608	14.5%	2193
26013 Newcastle	1900	1820	4.4%	2500
26010 Menlough (Mionlach)	5118	4990	2.6%	610.8
26004 Castlegar (An Caisleán Gearr)	4053	4135	-2.0%	1079.6
26002 Ballybrit (Baile an Bhriotaigh)	949	898	5.7%	366.5
26001 Ballybaan	13019	12298	6.9%	1710.4
26011 Mervue	1831	1796	1.9%	1510

Based on the more detailed results from the 2016 Census, **Table 18.10** illustrates the expansion in the number of households in Galway over time in the study area and in the suburbs despite the current high levels of traffic on the existing N6. The table reveals how population trends over time have been reflected in the number of

[12] Galway Rural (part) is a small ED (#27052) on the south-west shore of Lough Corrib

private households. The table shows that expansion into the rural areas of Bearna (Rural) has been well-established and continuous over the years, albeit from a small base. By comparison, expansion into the main village of Bearna and the townlands of Rahoon and Castlegar has been more recent, mainly from the 1990s. Established suburbs such as Dangan and Newcastle had experienced much of their growth prior to the 1990s, although the most recent Census results show that this could be changing.

Table 18.10: Houses by year built (2016)

	Pre 1971	1971 – 1980	1981 - 1990	1991 - 2000	2001 - 2010	2011: -	Unknown year	Total
Bearna (Barna Rural)	12.3%	11.2%	9.5%	19.8%	41.7%	2.4%	3.1%	1188
Bearna (Barna)	2.1%	4.4%	16.9%	34.5%	32.9%	1.8%	7.4%	5516
Galway Rural (part)	7.2%	9.1%	4.5%	5.5%	4.5%	2.7%	0	110
Rahoon	6.5%	9.8%	15.7%	27.1%	32.7%	1.5%	6.7%	1110
Dangan	9.6%	25.1%	30.3%	18.4%	5.2%	0.8%	10.7%	1512
Newcastle	25.4%	47.0%	12.1%	3.2%	2.5%	0.4%	9.4%	713
Menlough	6.1%	22.2%	25.3%	14.6%	17.9%	1.5%	12.4%	1823
Castlegar	5.2%	14.7%	9.8%	15.5%	40.2%	0.6%	13.9%	1566
Ballybrit	8.4%	7.2%	18.1%	32.4%	21.2%	0.3%	12.5%	321
Ballybaan	2.7%	6.6%	6.8%	13.3%	57.4%	16.%	11.6%	4554
Mervue	55.9%	16.8%	7.5%	1.9%	0.3%	0.3%	17.4%	755

Table 18.11 presents the figures for mode of journey to work, college or school and reveals high proportions of journeys by foot in the central or established neighbourhoods such as Dangan, Newcastle, Murrough and in Menlough. Levels of cycling are also in excess of 6% in these EDs. Journeys by foot also exceed 10% in Castlegar, Ballybrit and Ballybaan, but are understandably low in the urban/rural fringe area where vehicle use accounts for more than 50% of journeys. In Bearna, around 80% of people make their journey by car with the consequence that pressure is inevitably placed on the local road infrastructure, the environment and community wellbeing. Around one quarter of people in these EDs travel as a passenger or by bus, including a high proportion of students and school children.

Table 18.11: Journey mode to work, college and school (2016)

	On foot	Bicycle	Public transport	Car / van driver / motorcycle	Car passenger	Other / at home	Not stated
Bearna (Rural)	5.2%	2.0%	3.1%	51.0%	32.0%	4.0%	2.4%
Bearna (Barna)	6.9%	4.1%	11.1%	47.6%	25.6%	2.3%	3.4%

	On foot	Bicycle	Public transport	Car / van driver / motorcycle	Car passenger	Other / at home	Not stated
Galway Rural (pt)	0.1%	0.1%	0%	61.4%	29.5%	0%	3.4%
Rahoon	10.7%	5.7%	4.9%	36.0%	17.7%	1.6%	2.3%
Dangan	43.4%	8.0%	4.1%	26.8%	12.9%	1.3%	3.6%
Newcastle	49.6%	8.5%	4.8%	21.0%	11.5%	0.8%	3.8%
Menlough	34.0%	6.4%	5.8%	35.2%	13.0%	1.5%	4.0%
Castlegar	16.6%	6.3%	12.4%	42.3%	15.3%	1.5%	5.6%
Ballybrit	11.7%	3.2%	16.1%	47.0%	16.3%	1.7%	4.0%
Ballybaan	12.9%	2.9%	13.5%	42.33%	19.2%	1.2%	7.8%
Mervue	19.3%	4.2%	11.6%	37.4%	10.6%	1.4%	15.6%

Table 18.12 shows journey times to work, college or school. These conform to expectations in that journey times are less in the established neighbourhoods of Newcastle and Dangan and are extended in the urban/rural fringe. Most journeys are completed in less than 30 minutes in most EDs, but a further 20% of journeys take between approximately 30 minutes and three-quarters of an hour in the urban/rural fringe. Only 3.5% of journeys exceed three-quarters of an hour. However, given that some urban roads are near to capacity, and that most people travel to work or college by car, journey time is vulnerable to increases in traffic volumes and to incidents giving rise to congestion.

Table 18.12: Journey time to work, college and school (2016)

	< 15 mins	1/4 - 1/2 hour	1/2 - 3/4 hour	3/4 hour - 1 hour	1 hour - 1 ½ hours	> 1 ½ hours	Not stated
Bearna Rural	24.6%	38.8%	23.7%	3.8%	3.5%	1.3%	4.4%
Bearna	22.2%	42.4%	21.0%	3.8%	2.8%	1.5%	6.2%
Rahoon	25.2	33.1%	13.4%	2.1%	1.7%	0.7%	4.8%
Dangan	41.3%	39.5%	8.5%	2.3%	1.3%	0.7%	6.4%
Newcastle	52.6%	32.2%	5.6%	1.3%	1.4%	0.5%	6.5%
Menlough	31.8%	44.4%	12.0%	1.5%	2.0%	1.3%	6.9%
Castlegar	29.0%	38.8%	17.5%	2.8%	2.4%	0.9%	8.5%
Ballybrit	32.3%	39.5%	14.7%	4.1%	2.3%	1.1%	6.0%
Ballybaan	30.2%	36.0%	17.1%	3.0%	2.3%	0.7%	10.8%
Mervue	35.4%	31.6%	9.6%	1.8%	1.2%	0.5%	19.8%

In addition to residential development, areas have been zoned for major retail and light industrial development in Rahoon, along Seamus Quirke Road and east of the River Corrib in the vicinity of the Bodkin and Kirwan Junctions. The National University of Ireland Galway (NUIG) occupies a corridor of land beside the western bank of the River Corrib with teaching and research facilities located north and south of the Quincentenary Bridge, as well as extensive recreation facilities comprising the NUIG Sporting Campus to the north in Dangan.

Large light industrial and commercial estates are found to the east of the N83, particularly in the suburbs of Ballybrit, Parkmore and Briarhill and include the Ballybrit Industrial Park, the City East Business Park, Oldenway Business Park, Briarhill Business Park, the Galway Technology Park and the Parkmore Business Park. Commercial business parks are fewer in number, to the west of the River Corrib, the Galway West Business Park and the Gateway Retail Park are located in the vicinity of Rahoon and Clybaun. A large area is zoned for enterprise and commercial activity between Bóthar Stiofán in Knocknacarra/Clybaun across to the Western Distributor Road. One business park, Galway Business Park, is situated off the N59 Moycullen Road and benefit from proximity to the NUIG Campus.

18.3.2 Character

The study area commences in the rural area to the west and north of Bearna Village. Although the landscape retains elements of a wild and rocky vista there has also been a significant amount of new linear residential development in recent years. This development is adjacent to the few minor roads traversing the study area between which land use is largely low intensity agricultural. The proposed road development follows a corridor just outside of the built up residential areas of Clybaun and Letteragh on the edge of Galway City, but does cross the Dangan townland of established residential development and areas of amenity use to the east.

The same pattern applies east of the River Corrib where the corridor for the proposed road development traverses parts of Ballindooley and Castlegar. Further to the east, the area around Ballybrit includes extensive areas of commercial development and also the Galway Racecourse.

From a Human Health perspective, the health of the population in Galway is broadly similar to other areas within Ireland. In its most recent publication on Health Status and Health Service Utilisation 2010, the CSO provides information of a number of health statuses. The statistics are reflective of the region, in this case, the West of Ireland. It shows, for example, in terms of self-perception of Health Status, 85% of adults perceive their health as being either Very Good or Good. This compares to 89%in Dublin, 87% in the South West and 84% in the Midlands. There are also statistics on doctor diagnosed medical conditions including for example, asthma, chronic bronchitis, diabetes and mental health problems, as well as others. In all cases, prevalence of these conditions is similar to other areas of the country. In general, therefore, the statistics suggest a health status broadly consistent with the Irish population as a whole.

18.3.3 Significance

The proposed road development is intended to provide improved connectivity to the national road network for communities on the western side of the River Corrib which is only possible at present by using one of the four city centre bridge crossings. It will attract traffic from the city centre and suburbs, leading to improved journey time reliability and potentially facilitating the reallocation of the road space to public transport. It will also provide for an improved city centre environment for all due to reduced congestion and improved journey amenity, allowing walking and cycling to become safer, more practical transport modes. At present, bus patronage is less than 10%. Current journey times for both private vehicles and public transport are extended significantly by regular congestion particularly in the vicinity of the Bodkin Junction and Kirwan Roundabout, but also at the Browne Roundabout and along Seamus Quirke Road. Significant community severance is currently experienced along Seamus Quirke Road, the Western Distributor Road and along every section of the existing N6, including areas with important community and retail facilities. Although there are signalised crossings, wait times can be lengthy due to the volume of traffic. In the eastern half of the city at Briarhill, there is a pedestrian underpass, but crossings of any sort are necessarily prevented along much of the existing N6 in Ballybrit by a central barrier. While there are few community facilities in this area, the commercial and industrial estates to the north are important places of employment to which most access occurs by private vehicle.

The economy of Galway City has a strong representation of software, pharmaceuticals, medical devices and engineering businesses. Tourism is also an important economic sector and the city is the gateway to Connemara and the Aran Islands. As well as the economic benefit of the tourism sector, the city’s historic heritage, cultural and arts scene attract large numbers of visitors and provide city residents with a vibrant environment. Galway City itself has various well-known sites and holds numerous event and festivals throughout the year including the Galway Arts Festival, the Galway Food Festival, the Cúirt International Festival of Literature, the Oyster Festival and the Galway Races. In addition, the NUIG Sporting Campus, the River Corrib, Lough Corrib and Galway Bay are also used for walking, fishing, and a variety of water-based activities throughout the year.

High quality transportation access in and out of the city is essential to the sustainability of the city’s growth, the capacity of the tourism sector to drive regional development and to the city’s ability to stimulate economic development across the county, including more economically peripheral areas to the west of the city. To date, most industrial development has occurred in the east of the city where the best connections are to be found via roads to Dublin, Limerick, Cork and the east of the country. However, there are several large industrial or commercial estates which currently have very restricted access, in some cases only to the existing N6. The increasing volume of traffic in these areas impacts significantly on average journey times, especially at peak hours, and presents a threat to continued economic investment.

The route of the proposed road development generally avoids nucleated settlements with the exception of areas such as Dangan, Ballindooley/Ballinfoyle and Castlegar. There are areas of concentrated or linear residential development and also scattered development. Identities have emerged, often associated with historical townlands, local crossroads, schools or sports clubs. These sports facilities, together with the NUIG Sporting Campus, are well used by people living outside of the study area. There are also small family business premises and some equine activity.

18.3.4 Sensitivity

In the current baseline environment, there are limited opportunities for pedestrian crossings along the existing N6 away from dedicated crossing facilities. Combined with long wait times where these facilities are present, this imposes a particularly significant impact on sensitive or vulnerable population subsets such as young people, the elderly and people with disabilities. The CSO data records, rather high levels of disability (all types) in Rahoon (11.1%), Dangan (12.2%) and Newcastle (19.7%) relative to an average of 9.7% for the other EDs in the study area. These are neighbourhoods with a relatively high representation of older people and pockets of social disadvantage as indicated by the Pobal HP Deprivation Index (see also **Section 18.3.5**). Heavy traffic volumes, together with severance, noise and air quality impacts, reduce local quality of life, have potential implications for health and inhibit the ease of movement of people to schools, shops, medical centres and other community facilities. Road crossings can be awkward for those whose mobility is impaired and, away from crossing facilities, can entail an accident risk for all pedestrians. It can also be difficult for drivers to gain safe access to and from busy roundabout junctions. In addition, whilst there are some cycle lanes along the existing N6, these sometimes terminate at junctions without onward facilities, including for crossings. While the level of cycling in Galway City is comparable to other regional cities, the figures are low by an international comparison. Inadequate cycling facilities, poor journey amenity and safety hazards, greatly discourage cycle journeys from the suburbs into the city.

Galway City is an important national tourist destination. The attractiveness of the city to visitors partly depends on city centre traffic volumes remaining manageable and on vehicle access to the centre and the west not being subject to poor journey amenity, delay or congestion. Such factors impact negatively on the visitors' experience and their willingness to recommend Galway as a destination to others.

The proposed road development will also pass through the Galway Gaeltacht as shown in **Figure 18.1.001** and **18.1.002**. The Galway Gaeltacht is an area of cultural distinctiveness that is an important part of the county's identity and an attraction to visitors. This identity could be strengthened by the economic stimulus of the improved accessibility provided by the proposed road development.

In addition, some of the landscape in the west and central parts of the study area is of amenity interest or value. The corridor of the River Corrib is a sensitive landscape feature which is used for walking, rowing and angling and which links the city to its wider hinterland. Much of this corridor is occupied by lands managed by NUIG. These lands are accessible to the general public and are used by both university and non-university sports clubs and as an amenity. The university highlighted the role of these lands in providing for a unified campus and their importance in terms of providing sports and amenity facilities for attracting students and high-calibre staff. The concept of a unified campus has already been impacted by the partial physical severance incurred due to the Quincentenary Bridge on existing N6. Similarly, there are quiet roads and boithríns in the study area which are used for walking locally, including a historic mass paths. In particular, minor roads in the west of the study area are much used for walking, jogging and cycling. The study area is largely free of built development north of the existing N6, although there is much scattered residential development.

Residents consulted in the local community in the study area during the course of the assessment have often acknowledged the potential positive impacts of the proposed road development, noting in particular the potential for shorter travel times due to reduced urban congestion. People have also referred to the prospect for improved connectivity between parts of the city and the benefit this will have both socially and for employment. Concerns were simultaneously expressed regarding perceived environmental and community impacts, many of which mirror those received during the earlier public consultation. Such anxieties can sometimes impact on individuals' health and well-being prior to the commencement of works. Where possible, these concerns have been addressed during the design process or by the proposed mitigation with the net impact discussed in the relevant section of this and other chapters.

18.3.4.1 Identification of vulnerable groups

While every human being should be considered a sensitive receptor, the vulnerable are the most sensitive. These vulnerable groups may be more susceptible to impacts associated with the proposed road development.

Children and adolescents constitute a vulnerable group partly due to their need to be able to move around freely to and from school and recreational activities. They lack the experience and judgement displayed by adults when moving around traffic in public spaces. Studies[13] show that they may also be more sensitive than adults to air pollution and other environmental factors.

Elderly people constitute a very variable group when it comes to their need and scope for moving around the community. Generally speaking, the elderly people are slower in their movements and more health conditions may occur. Elderly people in general have greater sensitivity to air pollution and potential effects on the respiratory system and cardiovascular system and more likely to express anxieties in relation to potential air quality or noise impacts due to the proposed road development. There are many reasons for this sensitivity, including the possible presence of other medical condition such as respiratory or cardiovascular disease. Subtle changes in the environment have the potential to have an adverse effect that would not be experienced by younger more resilient persons. There are other vulnerable groups also, for example, persons with disabilities or persons with mental illness. It is important to note that, in this assessment, it is assumed that all areas contain highly vulnerable individuals including the old, the very young, disabled and persons with disabilities, as well as people who are sick today or who may be sick at the time the proposed road development is being constructed or operational. However, as noted above, there are some particular areas with higher levels of sensitive population subsets than others.

Vulnerable groups of people occur throughout the receiving environment for the proposed road development and include among others, a crèche, schools, nursing home and areas with a higher number of older family groups.

[13] http://www.who.int/ceh/risks/en/

18.3.5 Community Profile

Evidence shows that different communities have varying susceptibilities to health impacts both positive and negative as a result of social and demographic structure, behaviour and relative economic circumstance.

Whilst specific health data for individuals in the vicinity of the proposed road development is confidential and difficult to establish, a community profile has been used to establish the baseline and identify unequal distributions in existing factors such as deprivation or burden of poor health, in order that changes in community exposure to certain health pathways and their degree of impact on the population or community can be assessed.

A group made up of the Health Services Executive, Lenus and the Irish Health Repository have published health profiles for all the Local Authorities areas in Ireland and a health profile is available for both Galway City and County. The most recent profiles published relate to 2015 and have been used to establish a community health profile for the proposed road development.

The Health Profile identified that Galway City:

- "*has the lowest dependency ratio* in Ireland *of 34.9% (i.e. the number of those aged between 0-14 and 65 and over, as a percentage of the number of persons aged between 15 and 64). The national rate is 49.3%*
- *has the second most ethnically diverse population with 23.8% being non-white Irish. It also has the highest proportion of Travellers nationally of 2.3% (national 0.7%)*
- *is the third most affluent local authority area*
- *has the second highest education attainment levels of 45.0% (national rate 30.6%). The proportion of those with primary education only is 9.3% (national rate 15.2%)*
- *has the highest incidence of male malignant melanoma, and slightly above average for male prostate and colorectal cancers (Galway City and County data)*
- *is average or below average for the four main causes of mortality, all cause mortality and suicides (Galway City and County data)*
- in terms of the age breakdown of the population it shows that Galway City, has a relatively higher percentage of the population in the young adult ages from 20-35 and a relatively smaller percentage in the very young and older age groups than the national population. However, this demographic is not unusual for an urban setting in Ireland

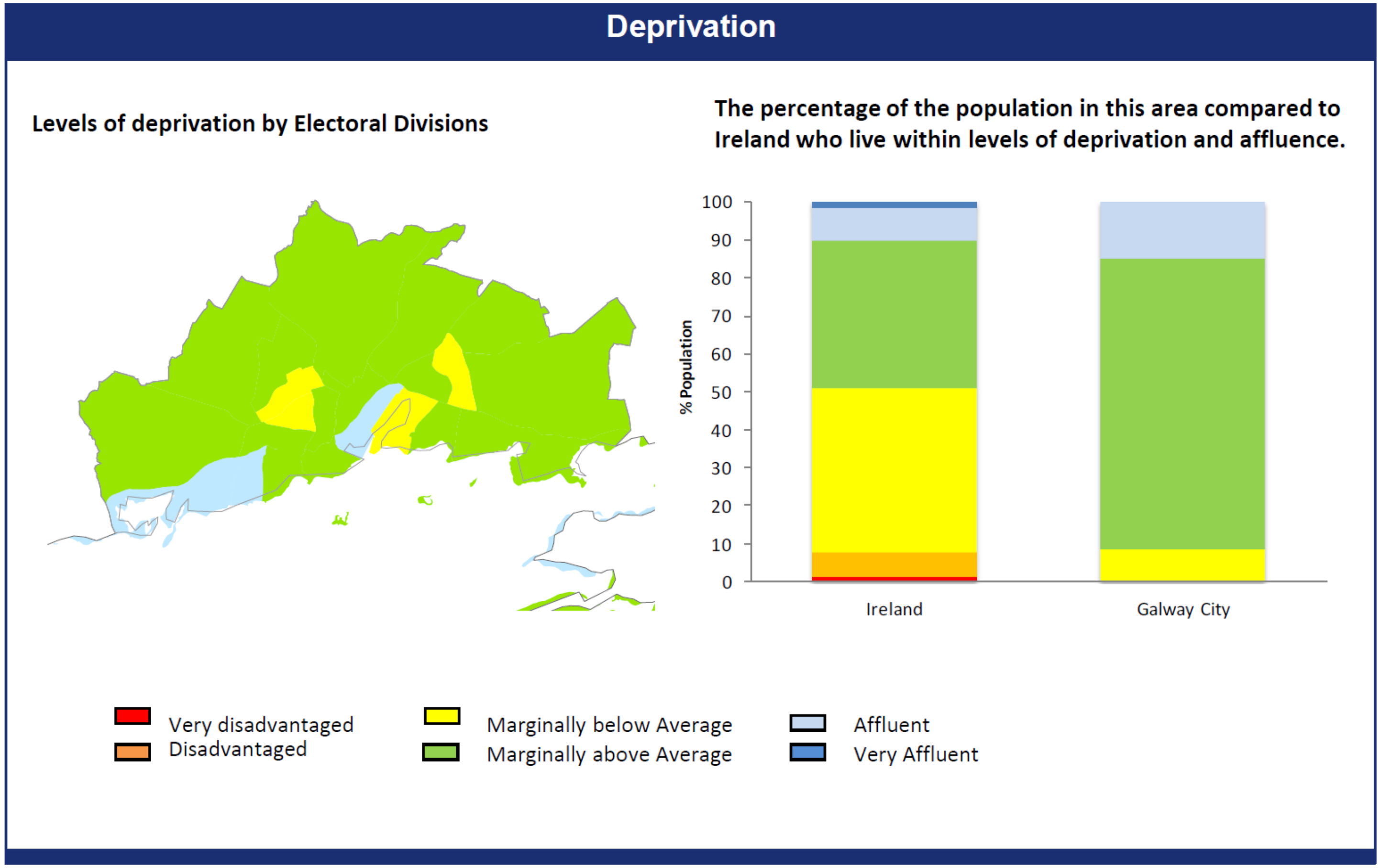
The Health Profile identified that Galway County:

- *Is the tenth most affluent local authority area nationally*
- *The Traveller population of 1.4% is above the national rate of 0.7%*
- *Has a low lone parent rate of 9.3% (national 10.9%)*

- *Has a low birth rate for mothers under 20 years of age at 7.0% (national 12.3%)*
- *Has the highest incidence rate of male malignant melanoma nationally, but is below average for female malignant melanoma, breast cancer, female colorectal cancer and male and female lung cancer (City and County data)*
- *Has average or below average mortality for the four main causes of mortality and for all mortalities (City and County data)*
- *Is below average for male and female deliberate self harm*

In terms of deprivation, the health profile report includes a map which shows deprivation levels as a percentage of population compared to national levels, see **Plate 18.2** for a copy of this map. It should be noted that the data shown on the map are averages and the scale of the map covers a relatively large area and does not give a true reflection of what is happening on a smaller more local scale. Areas which are categorised as affluent will contain small areas which are disadvantaged and similarly areas shown as disadvantaged will contain individuals or groups of considerable advantage. This shows geographically Galway City has relatively large areas which are marginally above average in terms of affluence or defined as affluent. However, there are parts of Galway City which score relatively highly on the Pobal Deprivation Index including the ED which contains the neighbourhood of Newcastle and areas close to the city centre.

Plate 18.2: Deprivation Map for Galway City (*Extract from Health Profile 2015 Galway City*)

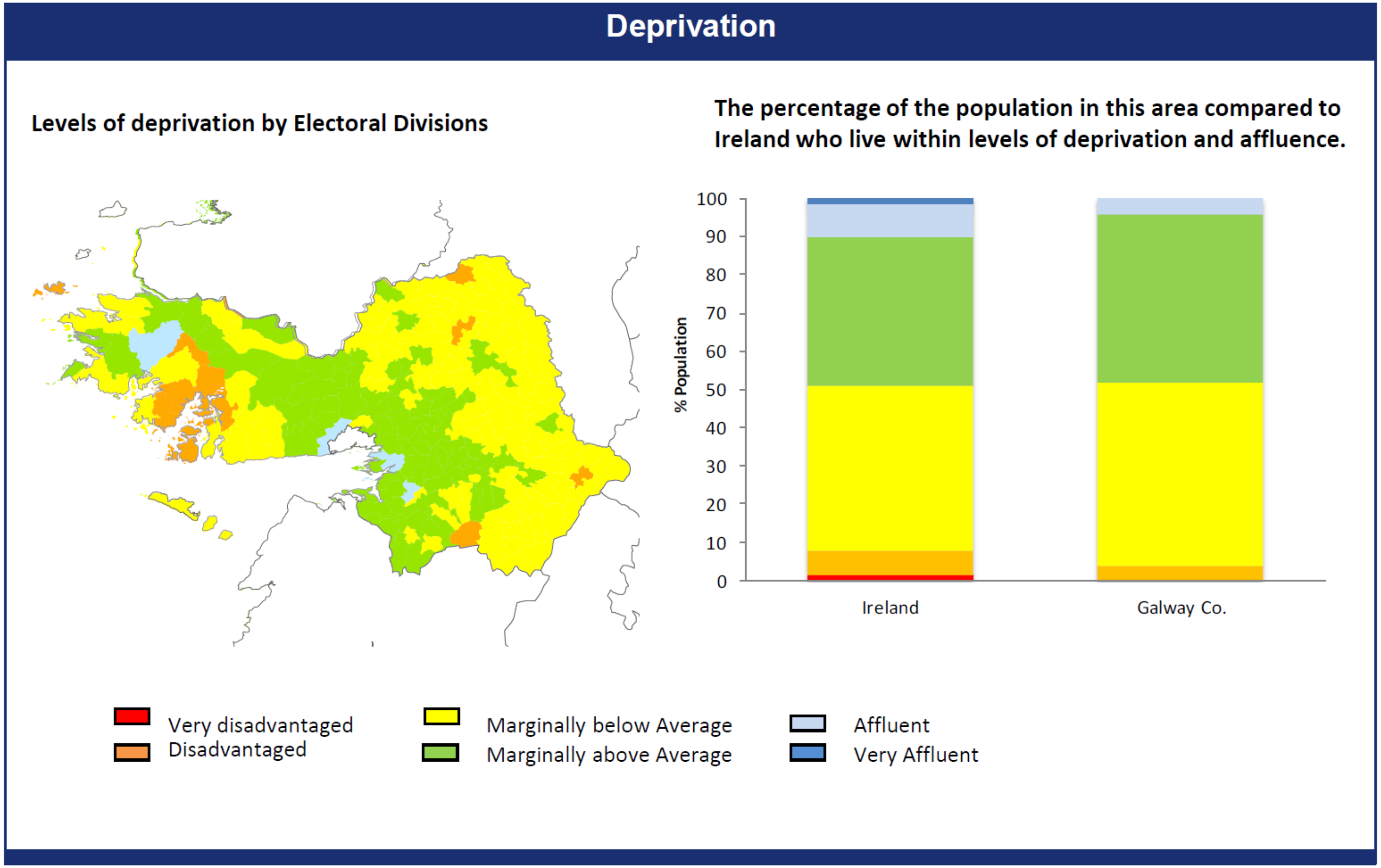


Note: There are parts of Galway City which score relatively highly on the Pobal Deprivation Index including the ED which contains the neighbourhood of Newcastle and areas close to the city centre.

When one looks at the deprivation map for Galway County (see **Plate 18.3** below), one can see an area described as affluent, immediately to the north and west of Galway City. Again as noted above, the data shown on the map are averages and the scale of the map covers a relatively large area and does not give a true reflection of what is happening on a smaller more local scale. Areas which are categorised as affluent will contain small areas which are disadvantaged and similarly areas shown as disadvantaged will contain individuals or groups of considerable advantage.

A copy of the Health Profile reports for Galway City and Galway County are included in **Appendix A.18.1** and **A.18.2** respectively.

Plate 18.3: Deprivation Map for Galway County (*Extract from Health Profile 2015 Galway County*)



18.3.6 Irish Language

18.3.6.1 Context

Irish (or Gaelic) is the national and first official language of the Republic of Ireland and it is among the official languages of the European Union. Despite its official status, the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 2009 declared the Irish language as "definitely endangered" and stated that it may be on its way to disuse. The Census of 2016 recorded that of 1.76 million people in the Republic of Ireland who indicated they could speak Irish, 73,803 said they speak it daily outside the education system, a fall of 3,382 on the 2011 figure.[14] A further 111,473 said they spoke it weekly, while 586,535 said they spoke it less often. Over one in four (421,274) said they never spoke Irish. Of the 73,803 daily Irish speakers (outside the education system), 20,586 (27.9%) lived in Gaeltacht areas.

Irish was the predominant language of the Irish people for most of our recorded history. By the tenth century Middle Irish was spoken throughout Ireland, Scotland and the Isle of Man; indeed, a common Gaelic literary language was used in Ireland and Scotland until the 15th century. Though Gaelic power and culture suffered in the century after the Anglo-Norman invasion, by the end of the thirteenth century "confidence had returned and the educated families of Gaelic Ireland embarked on a 300-year period of tremendous energy in the production of poetry, legal commentaries, translations of European medical treatises and works of genealogy and Irish history."[15] However by the seventeenth century, the language had lost its ascendancy and the dominant land-owning, merchant and professional classes were English.[16] As a result of economic pressures and British government prohibition of the use of Irish in public life, by the eighteenth and early nineteenth century, Irish was largely the language of the poorest sections of society. The Great Famine (1845 – 1849), and the socio-economic upheaval that followed, decimated the language. However, by the end of the nineteenth century, a vibrant language revival movement emerged in the form of the Gaelic League (Conradh na Gaelige). The creation of the Irish Free State institutionalised the language and

… government efforts to promote Irish, especially by maintaining the viability of the Gaeltacht, the remaining Irish-speaking areas, and insisting on compulsory instruction in schools, have thus far attained only limited success.[17]

The term "Gaeltacht" describes areas where the Irish language is considered the vernacular language. Ireland's Gaeltacht's were defined by a Government-appointed commission in 1926 and the boundaries were redrawn in 1956. It amounts to a total of 155 District Electoral Divisions, covering extensive parts of counties Donegal, Mayo, Galway and Kerry, all of which are on the western seaboard, together with parts of counties Cork, Meath and Waterford.

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[14] CSO 2017, 65.
[15] Duffy, 2000, 44.
[16] *Duffy, Atlas of Irish History, 2000*, 94.
[17] *Duffy, Atlas of Irish History, 2000*, 94.

Consolidated figures for numbers of speakers and volume of Irish use in the Gaeltacht, have been available since the mid-1920s with the government-appointed "Coimisiún na Gaeltachta" report of 1926 and the population census of the same year. The former recommended that the Gaeltacht, which until then had no administrative existence, be defined on a two-tier basis – what came to be known as *Fíor Ghaeltacht* (above 80% Irish-speaking) and *Breac-Ghaeltacht* (between 25% and 80% Irish-speaking).

The *Comprehensive Linguistic Study of the use of Irish in the Gaeltacht* (2007)[18] conducted on behalf of the Department of Community, Rural and Gaeltacht Affairs (now the department of Art, Culture and Gaeltacht) updated these definitions into categories based on percentage of daily Irish speakers and sociolinguistic profiles for each type of community:

- Category A (over 67% Irish-speaking)
- Category B (between 44% and 66%)
- Category C (less than 40%)

The position of the Irish language in the Gaeltacht is very fragile as a result of continuous erosion by a wide array of forces including the mass media, the provision of State services through English, popular culture and the historical and contemporary dominant status of the English language in Irish society. Furthermore, there has been a weakening of the language as a result of people coming to live in the Gaeltacht from elsewhere who have little or no Irish. While there is evidence that there is a high level of awareness of the importance of Irish in the community life of the Gaeltacht, there has been a major reduction in the numbers of parents using Irish as the first language of the household and in the use of Irish among young people in the Gaeltacht. With respect to the education system, primary schools contribute greatly in supporting and fostering the language as a community language, but post-primary education is frequently provided outside the Gaeltacht area and/or within a local town where English usage is more prevalent. For a multitude of reasons, Irish has almost ceased to be, and in some cases no longer is, the community language in a number of Gaeltacht areas.

The Government's *20-Year Strategy for the Irish Language 2010 - 2030*[19], has the principal objective of increasing on an incremental basis the use and knowledge of Irish as a community language. Specifically, the Government's aim is to ensure that as many citizens as possible are bilingual in both Irish and English. It is an integral component of the Government's Irish language policy that close attention be given to its place in the Gaeltacht, particularly in light of research which indicates that the language's viability as a household and community language in the Gaeltacht is under threat.

The total population of all Gaeltacht areas in April 2016 was 96,090[20], down 0.6 per cent from 96,628 in 2011. Of these, 63,664 or 66.3 per cent, indicated they could

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[18] Comprehensive Linguistic Study of the use of Irish in the Gaeltacht – Principle Findings and Recommendations – 2007: Research Report prepared for the Department of Community, Gaeltacht and Rural Affairs (http://www.pobail.ie/en/AnGhaeltacht/LinguisticStudyoftheGaeltacht/)
[19] http://www.ahrrga.gov.ie/app/uploads/2015/07/20-Year-Strategy-English-version.pdf
[20] CSO 2017, 69.

speak Irish, while 20,586 (21.4% of the total) indicated they spoke Irish daily outside the education system. This represents a fall of 11.2 per cent on the 2011 daily Irish speakers figure of 23,175. The number of people in Gaeltacht areas who indicated they spoke Irish less often than weekly decreased by 0.7 per cent from 16,244 to 16,137.

There are a large number of pre-school, educational, arts, sports, entertainment and employment organisations working on the ground throughout the Gaeltacht. These include community-based companies supported by Udarás na Gaeltachta. There are also a sizeable number of language-based enterprises operating through Irish. The following important organisations are based in the Galway Gaeltacht: Acadamh na hOllscolaíochta, TG4, RTÉ Raidió na Gaeltachta and An Coimisinéir Teanga.

18.3.6.2 The Galway Gaeltacht

The Galway Gaeltacht is the most populous of the country's Gaeltacht areas. It stretches for approximately 100km from Baile Clár, east of Galway City to Cloch na Rois in West Connemara. According to the 2011 Census, there were 48,907 people living in the Galway Gaeltacht. Of those aged 3 or over (a figure of 46,703), 66.3% (or 30,978), indicated an ability to speak some level of Irish. A total of 13,790 stated that they spoke some level of Irish every day (representing 29.5% of the population of the Galway Gaeltacht over the age of 3 years old). Approximately 15,300 of the total Galway Gaeltacht population resides within the suburbs of city.[21]

In 1926, the rural districts with the highest proportion of Irish-speakers were situated in the western half of the country. In 1956, the official Gaeltacht boundaries were officially revised. While the total Gaeltacht population in the state fell by nearly one fifth, the Galway Gaeltacht had an overall loss of just 1%; however, the Fíor–Ghaeltacht areas declined by 12%. The larger Breac-Ghaeltacht areas, which included Galway City, maintained their 1926 level.

The patterns of language usage in the Galway Gaeltacht during the period closely resemble those of 1926. Again, only three rural districts – Galway, Oughterard and Clifden – contained significant proportions of households in which Irish was the sole or main language in normal use. However, in all districts, there is evidence of a shift towards English. The revision of the Gaeltacht boundaries was designed to positively impact on Irish language use in both Breac- and Fíor–Ghaeltacht areas. It redefined the Galway Gaeltacht almost entirely within the boundaries of the three most western and rural districts – Galway, Oughterard and Clifden, omitting English-speaking pockets in these areas, and the Breac-Ghaeltacht areas in the eastern rural districts of Galway. Within the 1926 boundaries, the Gaeltacht in 1956 contained a population of 104,896, but the revised boundaries had a population 28,878.

Between 1956 and 1971, overall population levels in the Galway Gaeltacht declined, but then showed a sharp increase in the 1970s; however, patterns were different between the Galway rural districts and remaining areas. In the 1956-71 period, population levels in this district were stable, while in the 1971-81 period, they increased by 45%. By contrast, Clifden and Oughterard experienced

[21] Galway City Council (2016, 99)

significant population loss until 1971; after which only slight gains were seen up to 1981. Many of these changes are clearly related to the growth of Galway City, with the areas closest to the city experiencing the strongest population growth – in the region of 43%. As the population increased, the ratio of Irish speakers decreased. In the coastal zone between Galway City and Indreabhán (Inverin), population increased by 24%, but there was a language shift to English, particularly close to the city. In Bearna, for example, only 60% of the population were classed as Irish speakers, however this ratio increased to 92% towards the west of the county. Very high levels of Irish speaking (+90%) in the Galway islands were maintained.

Both the demographic and linguistic trends in the country's Gaeltacht areas forced a major reappraisal of government policy in the late 1950s and 1960s. This reappraisal included the abandonment of the policy of relying on agriculture for a sound economic base, and in the provision of a Government department dedicated to the Gaeltacht. As late as 1966, 72% of the workforce of the Galway Gaeltacht was still employed in agriculture. Over the following 15 years, this decreased to 41%. The establishment of Údarás na Gaeltachta in 1980 saw a greater emphasis on industrial development within Gaeltacht areas. From the 1970s onwards, Galway City grew increasingly important as a centre of third-level education and employment. In the recent 2016 Census, amongst the cities in the state, Galway City and its suburbs had the highest proportion of population who spoke Irish on a daily basis (3%).[22]

18.3.6.3 Planning context

The 2000 Planning and Development Act outlined the principle that all Local Authority County Development Plans should set out objectives in relation to the linguistic heritage of Gaeltacht areas within the county in question, these should include:

> *The protection of the linguistic and cultural heritage of the Gaeltacht including the promotion of Irish as the community language, where there is a Gaeltacht area in the area of the development plan*[23]

Subsequent Planning and Development Regulations (2001) from the Department of the Environment, Heritage and Local Government contain, within Article 33, the basis for the requirement that a Language Impact Assessment be prepared for a planning application within a Gaeltacht area.

Significant further requirements for public bodies to ensure better availability and a higher standard of public services, including the planning process, through Irish were enforced under the Official Languages Act, 2003.

The Gaeltacht Act 2012 was enacted with two primary objectives: (a) to provide for a new definition for the Gaeltacht and (b) to make amendments to the structure and functions of Údarás na Gaeltachta. The Act envisages that the Gaeltacht will in future be based on linguistic criteria instead of on geographic areas which has been

[22] http://www.cso.ie/en/releasesandpublications/ep/p-cp10esil/p10esil/gag/
[23] Planning and Development Act 2000, Section 10.2m

the position to date. Language planning at community level will be central to the new definition of the Gaeltacht.

Both Galway City and County Councils have policy goals and objectives in relation to the Gaeltacht and the Irish Language. Of most relevance to the Galway Gaeltacht has been the County Council's *Gaeltacht Local Area Plan 2008–2018* (which was amended in 2013). However, the Variations No. 2a and 2b to the Galway County Development which were adopted incorporate the Bearna Local Area Plan as amended and Gaeltacht Local Area Plan (LAP) as extended into the County Development Plan respectively[24]. This proposed variation, in conjunction with the County Development Plan, will inform and manage the future development of the Bearna and Gaeltacht areas. The Gaeltacht LAP as extended consists of the plan context, strategy, overview of the Districts and settlement plans for An Cheathrú Rua and An Spidéal. A number of other settlements in the Gaeltacht have their own Local Area Plan, for example Maigh Cuillin has a plan in situ until 2019.

18.3.6.4 Language Profile

The proposed road development traverses the following Electoral Divisions (EDs):

- Bearna (part) (County Galway) (CSO Area Code ED 27044)
- Bearna (Galway City) (CSO Area Code ED 26003)
- Rahoon (CSO Area Code ED 26015)
- Dangan (Galway City) CSO Area Code ED 26006
- Galway Rural (Part Rural) (CSO Area Code ED 27052)
- Mionlach (CSO Area Code ED 26010)
- An Caisleán Gearr (CSO Area Code ED 26004)
- Baile An Teampaill (Part Rural) (CSO Area Code ED 27042)
- Baile An Bhriotaihg (CSO Area Code ED 26002)
- Ballybaan (CSO Area Code ED 26001)

Of these, the EDs of Rahoon, Dangan, Galway Rural (Part Rural) and Ballybaan are not within Gaeltacht district, while the western portion of Baile an Teampaill (Ballintemple) is within the Gaeltacht. The proposed road development extends through an area of the Galway Gaeltacht which abuts and surrounds Galway City. Since the 1980s, this area has experienced rapid population growth and urban expansion. Critically the majority of the population is not of Gaeltacht origin and the use of Irish as the "family" language has continued to decline.

Table 18.13 below presents the percentage Irish speaking population (aged 3 years and over) in the District Electoral Divisions through which the proposed road development passes, and percentage of daily Irish use in 2011 and 2016. For this study, daily usage is defined by the number of people (a) speaking Irish daily within

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and outside the education system and (b) those speaking Irish daily outside the education system only.

Table 18.13: Language usage within the District Electoral Divisions through which the proposed road development will pass (based on CSO Small Area Population Statistics 2011 and 2016)

District Electoral Division	Total Population aged 3 or over		% Irish-Speaking		% Daily Irish Use	
	2011	2016	2011	2016	2011	2016
26003 Bearna (Galway City)	13,564	14,461	52.1%	50.0%	5.6%	4.8%
27044 Bearna (part) (County Galway)	3,462	3,586	66.4%	65.8%	7.9%	6.4%
27052 Galway Rural (Part)	123	146	65.0%	49.3%	8.9%	6.8%
26015 Rahoon	2,854	2,946	42.5%	42.8%	4.0%	2.8%
26006 Dangan (Galway City)	3,572	4,021	50.53%	47.3%	3.2%	2.4%
26010 Mionlach	4,823	4,960	44.8%	43.3%	3.5%	2.9%
26004 An Caisleán Gearr	3,912	3,894	37.0%	35.8%	2.6%	2.6%
27042 Baile An Teampaill (Part Rural)	1,402	1,424	50.7%	50.1%	2.1%	2.9%
26002 Baile An Bhriotaihg	865	915	39.2%	36.9%	3.2%	2.7%
26001 Ballybaan	11,482	12,271	33.8%	31.6%	1.8%	1.8%

These figures indicate that the daily usage of Irish (outside of the education system) within the environs of the proposed road development varies from just less than 2% to less than 8% (though the highest percentage was recorded within the least populated Electoral Division (Galway Rural ED 27052)). It is fair to say that while Irish is a community language within the study area for the proposed road development, it is far from being a dominant or significant one.

18.4 Characteristics of the Proposed Road Development

A detailed description of the proposed road development and construction activities are provided in **Chapter 5, Description of Proposed Road Development** and **Chapter 7, Construction Activities**. This section outlines the characteristics and activities of the proposed road development of relevance to human beings, population and human health.

18.4.1 Construction phase

An east to west build sequence is likely to be adopted and construction may be completed in two concurrent phases or a single overall contract:

- Phase 1 – N6 Coolagh to N59 Letteragh Junction – 9.9km (Including the N59 Link Road North and South)
- Phase 2 – N59 Letteragh Junction to R336 Coast Road west of Bearna - 7.5km

It is estimated that the main construction period will last for approximately 36 months. A variety of construction activities will occur simultaneously at a number of locations along the proposed road development, but will be phased at any particular location.

Construction of the proposed road development will include activities such as excavation, embankment and structural construction, tunnelling, piling, rock breaking and movement of materials within the fenced off working area. This will generate noise, dust and movement of machinery which will impact on human beings, population and human health. The duration of these works will vary. Construction will be undertaken using internationally accepted methods, for example working hours and noise and screens and in a manner which will minimise, as much as possible, any disturbance to the local residents and road users. Refer to **Chapter 7, Construction Activities** for further details of construction activities. Refer to **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration** for details on potential air and noise impacts during construction.

The proposed road development has been designed to avoid as many residential properties as possible, but given the built environment and the linear development of the city with housing along most roads radiating out of the city, its construction will unfortunately and unavoidably result in a number of property demolitions or acquisitions in particular areas. At some locations, a high proportion of the total number of properties in a cluster will be acquired as part of the proposed road development. As well as the direct adverse impact on the householders themselves, this will present a varying negative impact on remaining residents depending on the strength of community interaction that has evolved at each location and the sustainability of community facilities such as schools.

Commencing the description at Bearna, much of the construction work here will occur in a rural setting. However, the high number of one-off dwellings in this area will result in the demolition of some properties. Other residents will be in close proximity to construction works and associated impacts. To the north of Bearna, an overbridge is proposed between the Foraí Maola Road (Na Foraí Maola Junction) and the L5387 Troscaigh Road (Troscaigh Junction) to provide continued access in a north-south direction along both roads. At Ch. 2+500 the proposed road development will sever the L-13215 Ann Gibbons Road with access to the north provided instead by the L1321 Bearna to Moycullen Road which will meet the proposed road development at the Bearna East Roundabout. Temporary realignments will be required on the Aille Road to allow for bridge construction and traffic management at other locations where local roads cross the construction works.

A signalised junction (Cappagh Road Junction) is proposed between the proposed road development and Cappagh Road. This junction will facilitate access to the proposed road development for the community of Boleybeg to the north and for the Western Distributor Road to the south, enabling use of the proposed road development as an alternative to the R336 through Bearna for many journeys. A crèche is also located to the north of the proposed roundabout at Cappagh Road.

Another signalised junction with the Ballymoneen Road (Ballymoneen Road Junction) provides for access to the Rahoon Road and the hinterland around it including Ballyburke, as well for journeys to the communities of Boleybeg and Keeraun to the north-west and Mincloon to the south. A temporary night-time closure of Rahoon Road will be required to facilitate overbridge construction.

The N59 Link Road North and South will be constructed in a largely rural area. Six local access roads will be constructed on the southern section as required, including a realigned entrance to the Rosán Glas Estate. However, there will be a minimum impact on local traffic as most of this section is offline of the current road network. New link road access will be provided to the Gateway Retail Park, replacing the existing access from the Gort na Bró roundabout with a signalised junction. The N59 Letteragh Junction itself will entail large-scale construction works including the excavation of cuttings. A temporary night-time closure of Letteragh Road will be required to facilitate overbridge construction.

The proposed road development then crosses the N59 Moycullen Road in Dangan in the vicinity of the Ard na Locha and Augnacurra estates north of the junction with Circular Road. Night-time closures of the N59 Moycullen Road will be required along with temporary traffic management for diversions. The construction of the River Corrib Bridge will occur through an area of high recreational value at the NUIG Sporting Campus.

East of the River Corrib, a temporary diversion of Coolough Road may be required during the construction phase. The proposed road development will be elevated on a viaduct structure (Menlough Viaduct) east of the Coolough Road before entering the proposed Lackagh Tunnel from where it proceeds to connect with the N84 Headford Road at a grade separated junction. Temporary night-time closure of existing roads may be required at locations such as the Menlo Castle Bóithrín, Bóthar Nua and An Seanbóthar where overbridges are to be constructed.

A temporary diversion of School Road will also be necessary to allow for bridge construction. Major construction works will be required in the vicinity of the N84 Headford Road and N83 Tuam Road and temporary night time closures and diversions may be required. A grade separated junction is proposed with the N83

Tuam Road. An access road connecting with the N83 Tuam Road will provide a connection to six residential properties within the established community of Cappanabornia. Major excavation works will be required on the hill on the eastern side of N83 Tuam Road and for the Galway Racecourse Tunnel. The Parkmore Link Road and City North Business Park Link will be constructed in advance to maintain access. Further east, temporary night time closures of the R339 Monivea Road and Briarhill Business Park Road may be necessary. The existing junction with R339 Monivea Road is regularly congested by commuting traffic heading to the nearby office parks and construction traffic management will be required to minimise construction impacts.

18.4.2 Operational phase

Once operational, the proposed road development will enable the reallocation of existing road space within the city to public transport and smart mobility measures and provide an additional crossing of the River Corrib. This will alleviate congestion within Galway City which will result in reduced air and noise pollution. It will facilitate a more efficient public transport system and the provision of a multi-modal choice of travel including walking and cycling. The transfer of traffic will provide for improved journey times and journey amenity for all road users as well as reduced community severance along existing roads and a reduction in traffic noise along sections of these roads. There will also be positive impacts on general amenity and potentially the well-being and health of the local population due to the transfer of a proportion of the current high volume of traffic from existing busy urban streets. The proposed road development itself will facilitate the crossing of the River Corrib without having to negotiate the city and improve connectivity for the city either side of the River Corrib. It will also provide essential city street links to better distribute traffic.

18.5 Evaluation of Impacts of the Proposed Development

18.5.1 Introduction

This section of the chapter evaluates the potential impacts for the ‘Do-Nothing’ scenario followed by an assessment of impacts for the ‘Do-Something’ scenario during the construction phase and then the operational phase under the headings of journey characteristics, amenity, community severance, economics and tourism, Irish Language and human health.

18.5.2 ‘Do-Nothing’ Impact

18.5.2.1 Journey characteristics

The ‘Do-Nothing’ scenario of the proposed road development assumes the proposed road development is not built and that traffic management plans within the Galway City area are not in place. There is likely to be a continuation and worsening of the poor journey characteristics experienced at present due to traffic congestion. In line with traffic growth factors, traffic volumes will continue to increase along existing routes accessing Galway City. Over half of Galway's working population commutes from surrounding areas and must enter the city via one of the main radial arteries, often connecting to the congested existing N6 to reach employment destinations in the east or west. Regular delays, especially at peak hours, will continue as a characteristic of poor journey time reliability. Rat-runs on local roads which are not designed for such traffic volumes will continue to increase which has an associated safety risk. Such congestion would also undermine the potential to fully realise future development objectives such as the Ardaun LAP. Opportunities for improved public transport and the promotion of sustainable modes of transport such as walking and cycling will be restricted by the need to accommodate vehicle traffic flow.

18.5.2.2 Amenity

The high volume of private and commercial vehicle traffic within the city will also continue to provide for poor journey amenity and discourage walking and cycling together with the associated health benefits. The continuing need to accommodate traffic flow in response to a rising trend in traffic volumes will restrict opportunities to dedicate extra space to pedestrians, cycling and public transport, and make it more difficult for the city to realise its objective of concentrating new development within the city boundary. In addition, the general amenity of people living alongside the existing N6 and other major access roads will continue to be effected by traffic noise and poor air quality.

18.5.2.3 Community severance

The need to accommodate traffic flow restricts opportunities to provide crossing facilities. Combined with the poor journey amenity noted above, this will maintain the high levels of community severance that are currently experienced along major roads such as the existing N6 and could confine some vulnerable groups such as elderly people and children within particular communities surrounded by busy roads. The preceding demographic analysis highlights the presence of relatively high levels of disability in neighbourhoods surrounding the existing N6.

18.5.2.4 Economic and tourism

High traffic volumes combined with congestion will stifle economic development and limit the ability of Galway City and its environs to realise its status as a Gateway City. The city's ability to attract new business and investment will be greatly constrained by regular traffic congestion and poor journey time reliability. A 'Do-Nothing' scenario will also remove the opportunity for improved connectivity to economically peripheral communities in the west of County Galway. Although Galway City is already a major destination for tourism, the potential for tourism development will be inhibited by a continuation of the high level of traffic volumes and congestion. The experience of visitors may be diminished by delays experienced traversing the city and by the experience of heavy congestion on city streets. In particular, high traffic volumes and congestion experienced in an unfamiliar city will reduce the willingness of tourists travelling by car to enter the city centre to visit key destinations and to contribute to the local economy.

18.5.2.5 Irish Language

In the ‘Do-Nothing scenario, the proposed road development is not built, the Irish language usage profile of Galway City and its suburban periphery is likely to be unchanged. However, settlements and industrial activity located within the Gaeltacht areas further west of the city will continue to experience peripherality and disadvantage in terms of long commuting times and transportation delays. The lack of adequate connectivity has been identified as a significant barrier to the long-term sustainable economic development of the Gaeltacht by agencies such as Údarás na Gaeltachta.

18.5.2.6 Human Health

Traffic demands in Galway City and its environs will continue to grow whether the proposed road development proceeds or not (**Chapter 6, Traffic Assessment and Route Cross-Section**). The number of people living in Galway City and its environs has increased and is likely to continue do so as set out in the zoned areas in the City Development Plans. The most recent Census 2016 shows that the population of Galway City has increased by 5.8% since 2011 to 79,934.

Negative impacts (dust, noise, nuisance, etc.) currently experienced by people from traffic congestion on existing routes will continue and potentially increase as traffic increases.

From a noise point of view, the increase in traffic demands on the existing road network will result in increased noise levels over and above the current scenario at properties located along the main national and regional roads. Noise levels at properties identified as ‘hot spots’ and areas for noise management within the Galway City Noise Action Plan (2013–2018) will remain above the threshold noise levels for noise management and are likely to be further increased as a result of increased traffic volumes. Refer to **Chapter 17, Noise and Vibration** for further details on noise impacts in the ’Do-Nothing’ scenario.

In the ‘Do-Nothing’ scenario, traffic congestion will persist within Galway City and its environs with vehicles continuing to go through congested city centre routes with slow average speeds giving the potential for greater particulate emissions. Particulate emissions have received particular attention in recent years given increasing evidence of their health effects.

In the ‘Do-Nothing’ scenario, there would also be potential adverse impacts on social interaction and inclusion due to a persistence of high levels of severance along existing roads and the potential that this has for containing populations within particular neighbourhoods combined with the direct discouragement to the movement of sensitive groups. The risk of road accidents will continue, particularly for pedestrians and cyclists, due to the need to ensure traffic movements which may restrict opportunities for new dedicated crossing facilities and a reduced availability of road space for footpaths or cycle lanes.

18.5.3 'Do-something' - Potential Construction Impacts – Socio-Economics

18.5.3.1 Introduction

As discussed in **Section 18.4.1**, the proposed road development will entail a significant level of construction works over a period of approximately 36 months, although works in individual locations may continue for a few days to a few months. For the most part, construction work will occur in a rural setting, but in some locations there are concentrations of houses, distinct communities or a high density of individual properties. There are potential impacts in relation to residential property demolitions, temporary road closures or diversions, construction traffic and general amenity. Refer to **Chapter 7, Construction Activities** for further details of construction activities.

18.5.3.2 Journey characteristics

Temporary realignments, temporary night-time closures and stop-go arrangements will be required where minor roads meet construction works. Most impacts associated with these arrangements are likely to be imperceptible to slight negative in extent. The temporary diversion of Aille Road will not impact significantly on accesses or use of the road. Temporary night-time closures will present a slight impact at Rahoon Road and Letteragh Road.

Construction works in the area of the N59 Link Road South will occur in a largely rural area and present only slight impacts on local traffic movement. Along the mainline of the proposed road development, only temporary night-time closures of the N59 Moycullen Road are anticipated during which diversions will be provided.

The temporary diversion of Coolough Road (Bóthar Nua) will not impact significantly on access or use of the road. Likewise, a temporary diversion of School Road, Castlegar will not impact significantly on access to Castlegar National School (which includes Beoga pre-school), the nursing home or residential properties as it is a diversion which is immediately off-line of the existing road within the proposed road development.

Major construction works will be required in the vicinity of the N84 Headford Road and N83 Tuam Road. Temporary night time closures and diversions may be required on the N84 Headford Road, N83 Tuam Road, Briarhill Business Park Road and R339 Monivea Road and this will present some slight to moderate negative impacts on the journey time for people using the road at this time.

Refer also to **Table 18.14** and **Table 18.15** which summarises socio-economic impacts, mitigation measures and residual impacts in relation to journey characteristics during construction.

18.5.3.3 Amenity

General amenity

West of River Corrib

In some cases, residents will be in close proximity to construction works with consequent implications for noise emissions, air emissions and visual impacts. During the construction phase noise monitoring will be undertaken at the nearest sensitive locations to ensure construction noise limits are not exceeded. The selection of monitoring locations will be based on the nearest sensitive buildings to the working area as detailed in **Chapter 17, Noise and Vibration**. Refer to **Chapter 17, Noise and Vibration**, **Chapter 16, Air Quality and Climate**, and **Chapter 12, Landscape and Visual** for details on specific respective impacts.

For example, at Na Foraí Maola and the Troscaigh Road, there are over 30 properties that are located close to the route of the proposed road development and which could experience noise or air quality impacts due to construction works. The same observation applies to the proposed signalised junction with Cappagh Road where a crèche is also located. Material excavation, including the likely use of blasting, will be required at Ballard and at Letteragh. There is a cluster of properties in the community of An Chloch Scoilte close to the first of these blasting locations. See also **Chapter 17, Noise and Vibration** and **Chapter 16, Air Quality and Climate** for more details on construction noise and air impacts. Refer to **Chapter 9, Soils and Geology** for details on the blasting locations. Refer to **Chapter 12, Landscape and Visual** for details on visual impacts during construction at this location and other locations across the length of the proposed road development.

During the construction of the N59 Link Road North, there is a likelihood of impacts due to visual intrusion in the vicinity of Barnacranny, including St. James' Church, Bushypark and for visitors to its cemetery (see also **Chapter 12, Landscape and Visual** and **Chapter 17, Noise and Vibration**). To the south, works will be of a moderate scale, including for residential areas located beside connecting access roads from the N59 Link Road South. Only slight to moderate impacts on general amenity prior to mitigation would be anticipated, for example where the link road will be constructed along the edge of the Rosán Glas estate in Rahoon, including realignment works at the entrance to the estate, and similarly slight negative impacts due to realignment of Gort na Bró Road where this provides access to Gort na Bró estate. By comparison, the N59 Letteragh Junction itself will entail large-scale construction works including the extensive excavation of cuttings. Although in a largely rural area, these excavation works will present negative amenity impacts on the nearby small communities at An Chloch Scoilte and Knocknabrona and a proportion of other properties in Ard na Locha and Aughnacurra. See also **Chapter 17, Noise and Vibration**. Similarly, construction works on the N59 Link Road North will entail the excavation of a cutting before its connection with the N59 Moycullen Road. St. James' National School, Bushypark is located close to the construction works for the proposed road development, but neither the school nor its playing fields are located within the proposed development boundary. The route of the mainline of the proposed road development crosses the N59 Moycullen Road at Ard an Locha. Again, refer to the relevant chapters noted above for specific details on potential air, noise and visual impacts at specific locations.

To the east of the N59 Moycullen Road, the design of the proposed road development includes a viaduct across the NUIG Sporting Campus rather than an embankment and therefore provides for permeability beneath the proposed road development, reducing the potential impacts on the campus. The construction of this viaduct however, will have a very significant negative impact on local amenity, including the use of playing fields during the pre-mitigation phase. The sporting campus covers a large area and consists of a number of playing pitches for hockey, GAA and rugby, a sports pavilion and a running track. There will be a direct impact on part of the sports pavilion and on two playing pitches, one of which has flood lighting with the other having planning for conversion to a 3G pitch with flood lighting. During the construction phase, the central part of the Sporting Campus will become a construction site for a period of approximately 18 months. Access across the site will be maintained, but restricted for safety purposes. Construction traffic and works for the River Corrib Bridge will be managed to minimise interference with sporting activities and spectators. The existing sports pitches adjacent to the River Corrib will be unavailable for use while replacement pitches are constructed over a period that is likely to be nine months. However, as set out in **Chapter 15, Material Assets Non-Agriculture**, alternative pitch facilities will be provided to replace the existing pitches directly impacted by the proposed road development. The new facilities will include a floodlit 3G GAA pitch and a floodlit 3G training area. Associated site infrastructure will be provided for the drainage of these pitches along with furniture such as ball-stop netting and modification of the sports pavilion. Once these facilities are constructed they will be available for use within approximately one month.

The viaduct will extend to a bridge crossing of the River Corrib. Access to the bank of the River Corrib which is used as a local amenity and the river itself will be restricted at times during construction. The elevated works will have an impact on amenity use (see also **Chapter 12, Landscape and Visual**, and **Chapter 17, Noise and Vibration**), although the scale of the construction works on the bridge could also attract other temporary interest from members of the public wishing to view the bridge construction.

East of River Corrib

East of the River Corrib there will be a slight negative amenity impact resulting from the location of a proposed construction compound off Menlough Castle Bóithrín. The proposed road development will be elevated on a viaduct structure (Menlough Viaduct) after the Coolough Road. This will introduce construction noise and visual impacts (see **Chapter 12, Landscape and Visual**, and **Chapter 17, Noise and Vibration**). The existing An Seanbóthar unsurfaced road provides a loop connection for occasional walking between the communities of Coolagh and Menlough. It will be used by some construction traffic to access the works and this will impact on local amenity use. Upgrading of the bóithrín will be required to allow for this construction traffic and a subsequent connection to an emergency exit road for eastbound traffic entering the proposed tunnel. Given that the lane is currently free of motorised traffic with the exception of farm access, its use for construction traffic will present a moderate negative impact for some local people who use the Bóithrín for amenity.

The Lackagh Tunnel is located away from residential or amenity use. At the N84 Headford Road, a large proportion of the total number of residential properties will be acquired within the vicinity of the proposed N84 Headford Road Junction. Noise impacts are likely for adjacent properties which remain. The same observation applies in Castlegar in the vicinity of Hynes Bóithrín and School Road. Whilst there is no direct impact on Castlegar National School, the school does have an autistic facility which would be sensitive to construction noise which is assessed below in **Section 18.5.5**. Again, refer to **Chapter 12, Landscape and Visual**, **Chapter 15, Material Assets Non-Agriculture**, **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration** for specific details on air, noise, visual and material asset impacts at specific locations.

An impact on general amenity will apply for at least six households at Cappanabornia which are located beside the N83 Tuam Road. This impact arises from the construction of a new access road in the vicinity of the N83 Tuam Junction and the visibility of construction works on the hill facing these properties on eastern side of the N83 Tuam Road (refer to **Chapter 12, Landscape and Visual**).

A construction works programme will be agreed with Galway Racecourse for the proposed 230m cut and cover tunnel. The programme will involve the cessation of construction works during the summer/autumn racing schedule to avoid disruption to participants and spectators of the racing events. Refer also to economic impacts in **Section 18.5.3.5 - Economic** below.

Residential demolitions and acquisitions

From the outset of the design of the proposed road development every effort was made to avoid property demolitions where possible. However, there are still unfortunately and unavoidably a number of property demolitions that are necessary for the construction of the proposed road development and to secure the many benefits of the proposed road development. A total of 44 residential properties will require demolition with an additional 10 residential properties to be fully acquired.

Refer to **Chapter 15, Material Assets Non-Agriculture** for the precise nature of these potential impacts.

The demolition or acquisition of these properties will be a major negative impact of the proposed road development, both for the occupants and at a community level. There will be a clear and very significant impact on the occupants themselves. In addition, where neighbouring or nearby properties remain, there is likely to be a negative impact, of varying significance, on community ties and the amenity of remaining residents.

<u>West of River Corrib</u>

Five residential properties will be demolished at Na Foraí Maola and two residential properties will be acquired. In addition, one landholding with full planning permission for the construction of a residential property will require full acquisition. The boundary of the community is ill-defined and most of these properties are of relatively recent construction. Nevertheless, there are just over 20 residential properties at this location which includes a cul-de-sac off the local road. Consequently, the impact of the loss of five properties is likely to have a significant negative impact for this small community. Two further properties are being acquired in the community of Ballard where residential development stretches along two minor roads to the north.

One residential property will be demolished at Ballyburke, one off the L-1323 Letteragh and two will be demolished and one acquired at Letteragh. Approaching the N59 Moycullen Road, one property will be acquired and one property demolished at Bushypark beside the N59 Link Road North. Near Dangan, two properties will be demolished and one acquired at Ard na Locha, an estate of four houses and two sites for dwellings, and five properties will be demolished and one acquired in Aughnacurra Crescent, an estate of 14 residential properties. (refer to **Chapter 15, Material Assets Non-Agriculture**). These estates function as small communities which are separated from other residential development along the N59 Moycullen Road. Given the size, the level of impact will have an effect at a community level. The high proportion of premises impacted presents a very significant negative impact on the amenity of the remaining residents.

<u>East of River Corrib</u>

East of the River Corrib, two properties will be demolished in Menlough. Construction of the proposed N84 Headford Road Junction will require the demolition of 14 residential properties at this location out of a total of 22. The loss of a high proportion of established properties in this area represents a major impact for the occupants of the neighbouring houses that are directly affected. While there have been changes in occupancy in recent years and neighbourhood interaction is somewhat discouraged by the heavy traffic on the road, the demolitions will nevertheless present a significant negative community impact on remaining properties. Some occupants may return to live in the immediate area or north of the proposed road development where there are pockets zoned for residential development, although most land to the north of the proposed road development is not currently zoned as residential.

To the east, nine residential properties are proposed for either acquisition or demolition in Castlegar, along Hynes Bóithrín (two demolitions) and on School Road (four demolitions and two acquisitions). A strong sense of community exists here, noting also the community focus on the school. While the number of demolitions is fewer than at the N84 Headford Road, a similar scale of negative impact can be expected on both those directly affected and on those who remain.

Three residential properties are due for demolition in Cappananbornia on the east side of the N83 Tuam Road. One further property is proposed for demolition in Ballybrit and two in Briarhill.

Refer also to **Tables 18.13** and **Table 18.14** which summarises socio-economic impacts, mitigation measures and residual impacts in relation to severance during construction.

18.5.3.4 Community Severance

While any physical severance will be temporary in nature, the construction work in the west of the study area, for example at Na Foraí Maola and Cappagh will introduce a sense of social severance between properties and between areas north and south of the proposed road development even though physical connectivity is maintained. Social severance is likely to be felt most acutely by local residents where family members or friends are located on the far side of the proposed road development. However, given that the scale of construction works here will be less than for locations to the east of the River Corrib, this will be slight in degree. The L13215 Ann Gibbons Road will be permanently severed by the proposed road development and this is discussed further under operational impacts in **Section 18.5.4**.

As discussed in **Section 18.5.3.3**, while restrictions will apply for reasons of safety, continuous access will be maintained to the riverbank walk (or temporary diversion of same) and to the current small number of pitches to the north of the proposed River Corrib crossing at the NUIG Sporting Campus. The more significant severance will therefore be psychological rather than physical.

More significant construction related severance will occur in Castlegar where the effect will be of moderate significance despite the maintenance of connectivity.

It is proposed that construction traffic will travel from the western distributor road north along the Cappagh Road to gain site access. Most residential development is to the east of the Cappagh Road and crossing facilities are provided at the Cappagh Park sports complex. Similarly, it is proposed that construction traffic will travel north along the Coolough Road (Bóthar Nua) to gain site access. Construction traffic along the N84 Headford Road south of the proposed junction will present a slight negative severance impact, although new pedestrian crossing facilities are included in the design of the proposed road development along the N84 Headford Road.

18.5.3.5 Economic

The construction works will generate demand for inputs and services. CSO data indicates a gross construction multiplier of 1.5. As this value encompasses all forms of construction including house building, the figure for infrastructure could be somewhat lower given the more intensive use of machinery and import content. On the other hand, the bulky nature of many construction inputs should ensure that much of the income is retained within the State. Many of these inputs will be purchased across Ireland and will therefore contribute to the national economy, although some purchases, of services in particular, will likely to be made from the local businesses providing an economic benefit to these and to local employment.

Through the construction phase there will be some variation in the numbers of staff working on site. It is anticipated there will be 250-270 staff directly employed on site, rising to 300 staff at peak construction. This level of employment will provide a positive economic impact to the local economy in terms of spending on food and accommodation, although a proportion of workers are likely to already reside in

Galway. The employment multiplier implies the creation of one additional full-time equivalent jobs for every two people employed full-time on the project.

<u>West of River Corrib</u>

Impacts on the NUIG Sporting Campus are as described above under **Section 18.5.3.3 – Amenity**. The impact on sports pitches and the sports pavilion during construction can also be expected to have a slights economic impact due to loss of income from use by non-university clubs.

<u>East of River Corrib</u>

A very significant impact is anticipated on a business located on the N84 Headford Road which bottles water and distributes fruit and vegetables. The impact arises from the effect of landtake on one warehouse and an impact on the company's raw material supply.

The proposed road development will cross Lackagh Quarry which is currently inactive. Whilst the quarry is currently inactive there are rock reserves in the upper bench of the quarry. Refer to **Chapter 9, Soils and Geology** for details on potential impacts on future quarry reserves.

At the N83 Tuam Road, the alignment of the proposed road development between here and the eastern end of the Galway Racecourse Tunnel requires the acquisition of a builders providers store and landtake from other commercial businesses. Businesses, including a car dealership and the An Post sorting centre, could be affected by the need for traffic management during construction. The extensive nature of the works associated with the N83 Tuam Road Junction is likely to have a temporary impact on the visibility for customers of the car dealership, although this can be mitigated. There is also potential for environmental impacts on businesses adjacent to the racecourse in the Parkmore Business Park, some of which are engaged in activities that are potentially sensitive to vibration and air quality. See **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration**.

The proposed Galway Racecourse Tunnel will entail the acquisition of lands and the demolition of stables. It is proposed that the stables will be replaced with temporary stables for the duration of the construction of the proposed tunnel until such time as the permanent stables are provided. Both temporary and permanent stables will need to be of at least equivalent quality to the existing stables. Wells used for watering of the track will also be impacted. Works on the tunnel itself will be timed for periods outside of the racing calendar so as to avoid amenity and economic impacts on the functioning of the racecourse See **Chapter 16, Air Quality and Climate**, **Chapter 17, Noise and Vibration** and **Chapter 15, Material Assets Non-Agriculture** for further detail on these impacts and how they will be mitigated and minimised so as not to interfere significantly with business activities.

Approaching the existing Lynch Junction at Briarhill, the construction phase will have an impact on a car dealership located on the edge of the Briarhill Business Park. This will involve landtake mainly from an area that is currently used for customer parking and there will be a need to reconfigure existing services such as the car wash, fuel pump and underground fuel tanks, parts store and waste facilities. In principle, these can be fitted within the residual lands.

18.5.3.6 Tourism

The construction phase will not have a significant impact on tourism as the construction works are, for the most part, located away from areas visited by tourists. The alignment of the proposed road development means that evidence of construction works will be largely outside of the city centre and would not, for the most part be visible to tourist traffic. Tie-ins with the existing N6 will not impact significantly on traffic flow and the attraction of the city for tourism. Traffic diversions on the N59 Moycullen Road, N84 Headford Road or N83 Tuam Road are only proposed to occur at night and as such should not affect tourist traffic. The main potential issue would be racing events at the Galway Racecourse, but as noted above, construction of the cut-and-cover tunnel will proceed intermittently over a three year period to avoid disruption of racing events. Other tourist destinations include the River Corrib corridor and the NUIG Sporting Campus. Construction of the River Corrib Bridge will have a slight temporary negative amenity impact due to works affecting the impact on the natural setting.

Refer also to **Table 18.14** and **Table 18.15** which summarise socio-economic impacts, mitigation measures and residual impacts in relation to economic activity during construction.

18.5.3.7 Ecosystem Services

Ecosystem services provide many varied benefits that humans freely gain from the natural environment. A properly functioning ecosystem has the capacity to regulate and support the natural environment that contributes to human well-being under categories such as (having regard to the Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (2013)):

- provisioning services e.g. wild foods, crops, forage and fresh water
- regulating services e.g. filtration of pollutants by wetlands, climate regulation through carbon storage, water cycling, pollination and protection from erosion
- cultural services e.g. recreation, spiritual and aesthetic values, education
- supporting services e.g. soil formation, photosynthesis and nutrient cycling

The environmental assessment of the proposed road development has considered potential impacts on ecosystem services through the assessment of the environmental factors (pathways) through which ecosystem services could be affected such as water, soils, air, noise and general amenity and relied on the assessment detailed in **Chapter 8, Biodiversity** in terms of potential impacts to biodiversity and indirectly to ecosystem services. There are no impacts identified in those assessments which would result in a significant residual impact on ecosystem services during the construction of the proposed road development.

18.5.3.8 Summary

In summary, the construction phase will have mostly slight negative impacts on journey characteristics due to local traffic diversions. More major works would be necessary for the N84 Headford Road and N83 Tuam Road, but any diversions are proposed to occur at night when traffic levels are lowest. There will be visual, air quality and noise impacts on properties closest to the works which are addressed in **Chapter 12, Landscape and Visual**, **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration**, but the principal impact relates the residential demolitions and acquisitions required at various locations within the study area (ref **Chapter 15, Material Assets Non-Agriculture**). In three cases, the demolitions represent a high proportion of the total number of properties at a specific location. While subject to financial compensation as part of the compulsory purchase process, this negative impact will be realised most notably by the occupants, but significant impacts can also be expected at the community level addressed in this chapter due to impacts on local identity and community interactions. Significant construction impacts apply to the NUIG Sporting Campus which will be addressed through mitigation measures during the construction phase and further mitigation measures to maintain the integrity of the complex in the following operational phase (see **Section 18.6** below for the proposed mitigation measures).

18.5.4 'Do-Something' Potential Operational Impacts – Socio-Economics

18.5.4.1 Overview

Once operational, the proposed road development will attract traffic from the city centre and this in itself will provide for improved journey times and journey amenity along existing roads. The transfer of traffic will facilitate the reallocation of road space to public transport and the provision of walking and cycling facilities. As a result, there will be positive impacts on general and journey amenity and the health of the local population. The proposed road development will facilitate vehicle crossings of the River Corrib without having to negotiate the city centre and will provide essential links with city arteries to better distribute traffic. This new River Corrib crossing will also provide connectivity back to the city on both the east and west side of the river. There will be positive impacts for Galway City's economy due to improved accessibility and connectivity for commerce, goods movement, tourism and commuting. There will also be positive impacts for areas in the west of the county for which there will be improved connectivity to the east of the country and further potential for economic growth and tourism.

The operational phase of the proposed road development will also introduce some negative impacts, for example noise and visual intrusion, to areas that are currently quiet and semi-rural. It will also introduce an element of social severance between people living north and south of the proposed road development, who, in principle, will remain part of the same wider community.

18.5.4.2 Journey characteristics

The proposed road development will improve connectivity for Galway City and its environs and also areas in the west of Galway County, including access to the N59 Moycullen Road (for Moycullen, Oughterard and Clifden) and the R366 Coast Road (for Rossaveal and Connemara). Connectivity will be improved between the M6 east of Galway, the M17, the N83 Tuam Road, N84 Headford Road and N59 Moycullen Road. The transfer of a proportion of traffic to the proposed road development will help to relieve the level of traffic currently experienced on the existing N6. It will also provide opportunities for new facilities for pedestrians and cyclists as detailed in the Galway Transport Strategy (GTS).

Refer also to **Table 18.14** and **Table 18.15** which summarise socio-economic impacts, mitigation measures and residual impacts in relation to journey characteristics during operation.

West of River Corrib

As the proposed road development commences to the west of Bearna, it is expected to have a significant positive impact by attracting much of the current traffic flow away from the village of Bearna and the western suburbs of Galway City. This will be particularly significant during the morning and evening peak periods when congestion can occur from the 'Twelve Pins' junction in Bearna all the way into the city or due to vehicles accessing shops in the centre of the village. A reduction in traffic and a significant positive impact is anticipated in the village as a reduced level of traffic is predicted to remain on this section of the existing R336 (see **Chapter 6, Traffic Assessment and Route Cross-Section**). The Bearna LAP proposes that the village centre would, in due course, be provided with an inner relief road such that some of this impact could be expected to occur in the future even in a 'Do-Minimum' scenario. Variation No. 2a to the Galway County Development Plan (2015-2021) which has been adopted incorporates the Bearna LAP into the County Development Plan. However, while a relief road on its own would involve through traffic being directed through built-up parts of Bearna, the proposed road development moves this traffic out of the village core.

The Bearna East Roundabout will facilitate access to the proposed road development for the numerous residential households in the vicinity and to community facilities to the north of Bearna including the Bearna GAA Club and the Barna Golf and Country Club. This improved connectivity represents a net moderate positive impact, although some local residents could experience slight delays in accessing community facilities due to the longer journey to cross the proposed road development where currently there is direct access via a single local road. The Bearna East Roundabout will also provide a link to the N59 Moycullen Road although the current poor standard of this road towards the northern end means that most people wishing to make this connection are more likely to use the N59 Letteragh Junction.

A signalised junction (Cappagh Road Junction) will provide access from the proposed road development to the communities of Cappagh, Boleybeg to the north and to the Western Distributor Road and wider Knocknacarra area to the south. A lot of individual residential development has occurred here in recent years and this junction, along with others in this section, will provide a net moderate positive impact in terms of improved local connectivity and journey amenity while also reducing pressure on unsuitable minor roads. It will also improve journey amenity and contribute to the positive impact of traffic reductions in Bearna. The Cappagh Road Junction also provides connectivity to a crèche which is located to the north of the proposed road development.

Overall, the traffic projections indicate that there is likely to be a modest transfer of traffic from the Western Distributor Road to the proposed road development. The Ballymoneen Road Junction would have a moderate positive impact by providing connectivity to Ballyburke and the Western Distributor Road. The connection north to Rahoon Road via Ballymoneen Road is narrow so most other traffic is expected to use the proposed N59 Link Road South from Letteragh Junction.

The proposed N59 Letteragh Junction itself will be a grade separated junction connecting the proposed road development with link roads to Rahoon Road and the N59 Moycullen Road and will provide a very significant positive improvement in connectivity between the western suburbs of Galway and regional destinations. The N59 Link Road South will also provide a connection with the Letteragh Road and thereby also a connection with the dispersed residential communities of Drum and Tonabrocky. As with the above connections to local communities, this will provide for positive impacts on connectivity and journey amenity given the narrow and sub-standard design characteristics of some local roads. The proposed N59 Link Road South will distribute traffic, from the proposed road development, within the suburban area via its connections with several existing local roads to connect with residential areas, retail parks and community facilities. This will provide a degree of relief from traffic pressure in an area which is currently subject to regular congestion.

The connection provided in the other direction by the N59 Link Road North will relieve the congestion currently experienced by traffic attempting to access the N59 Moycullen from the city, including tourist and other traffic heading towards Clifden. Compared with a ‘Do-Nothing’ scenario, relief from congestion would apply especially at the Browne Roundabout given that right hand turns are prohibited from the preceding junction between the existing N6 and Newcastle Road Upper. The connection would provide a very significant positive impact to journey characteristics. Based on traffic predictions, it would reduce slightly the volume of vehicles on the N59 Moycullen Road into Galway City including Circular Road, Thomas Hynes Road and Newcastle Road Upper where educational and other community facilities are located.

Connectivity for pedestrians and cyclists is provided for in the design of the proposed road development. Crossing facilities for pedestrians are proposed for the junctions at Bearna East, Cappagh and Ballymoneen. A pedestrian footpath is included along the N59 Link Road North and a pedestrian crossing sequence will be included in the signalised junction proposed between the N59 Link Road North and the N59 Moycullen Road. The N59 Link Road North and South will include public lighting and pedestrian refuge islands at junctions. A cycle path will be included along the N59 Link Road South. Cyclists will, however, be encouraged to use the shorter existing urban routes which in most cases will provide more appropriate connections between origins and destinations. Traffic will have been reduced on many of these roads as a consequence of the proposed road development.

East of River Corrib

The N84 Headford Road Junction will permit vehicles using the proposed road development to access Ballindooley, Ballinfoyle, Headford, Ballinrobe and other communities such as Cong to the north of Galway City. As with the N59 Letteragh Junction, it will also permit direct access to the proposed road development without the need to enter Galway City. As such, the junction provides a significant positive impact on journey time and amenity to regional locations. The improved connection will also provide people living in Ballinrobe with the option of using the proposed road development for journeys to Dublin and the east as an alternative to the N5 or the lower capacity R661 and N60 roads through Claremorris.

The new accessibility provided by N83 Tuam Road Junction and the Parkmore Link Road to the City North, Ballybrit, City East and Parkmore Business Parks represents a profoundly positive impact on journey characteristics and for the city's economy given the number of companies located here (see **Section 18.5.4.5** below). The Parkmore and City North Business Park Link Roads will provide accessibility to the Parkmore Industrial Estate to the north and to the Ballybrit and City East Business Parks and Morris Junction to the south. The improved accessibility will significantly reduce peak time congestion at the junction between Ballybrit Crescent, the R339 Monivea Road and the existing N6 at the Lynch Junction. The same observation applies at the Morris Junction with the existing N6.

On-road cycle tracks are proposed for the Parkmore Link Road and the City North Business Park Link Road. Lands to the south are zoned for new development and will benefit from the improved accessibility. The connectivity provided by the Coolagh Junction represents no change with the existing baseline situation, but the transfer of much traffic to the proposed road development will relieve traffic pressure relative to the existing junction and reduce delays at the existing Lynch Junction.

18.5.4.3 Amenity

Journey amenity

The combination of new connectivity and transference of traffic provided by the proposed road development and discussed under journey characteristics will have the effect of reducing journey time in many cases, but also of relieving congestion along the existing N6.

Refer also to **Table 18.14** and **Table 18.15** which summarise socio-economic impacts, mitigation measures and residual impacts in relation to amenity during operation.

<u>West of River Corrib</u>

A slight negative impact will arise from the increase in traffic predicted to occur along the R336 between the centre of Bearna Village and the Bearna West

Roundabout on the proposed road development, although there are no community facilities on this stretch of road.

The transfer of traffic to the proposed road development will reduce the level of traffic currently using the local road network to the north of Bearna and linking onto the Rahoon Road and Letteragh Road to avoid the congestion on the R336 and the Western Distributor Road.

The transfer of traffic to the proposed road development will reduce the level of residual traffic on the R336 and Seamus Quirke Road together with the prospect of congestion on these roads and at the Browne Junction providing at least a moderate positive impact. This will present an opportunity to provide continuous urban cycle lane facilities and more pedestrian and cycling crossing facilities in line with the GTS with a lesser risk of such facilities adding to congestion (see **Section 18.7.3 Cumulative Impacts**).

East of River Corrib

The proposed road development will reduce traffic on the existing N6 western approach to the Kirwan Roundabout, also reducing the prospect of congestion at this location despite a prediction of higher traffic volumes on the N84 Headford Road. This will provide a slight to moderate positive journey amenity impact. It will also present an opportunity to provide improved cycle lane and pedestrian facilities in line with the GTS.

The transfer of traffic to the proposed road development will reduce the level of traffic currently using the local road network between the N84 Headford Road and the N83 Tuam Road, along School Road, Castlegar, to avoid the congestion on the existing N6.

Given the access to the city provided by the proposed road development, traffic volumes at the junction between the N83 Tuam Road and the existing N6 are predicted to be slightly higher (3.7%) under a medium growth scenario by the Design Year (2039). Consequently, there is no change in journey amenity for drivers wishing to use the existing junction between School Road or Bothar an Chóiste to Castlegar and the N83 Tuam Road, although peak time use by commuters of this minor road will be reduced by the availability of the proposed road development itself and by reduced traffic on the existing N6 west of the N83 Tuam Road Junction. A 36% reduction in AADT is predicted on the existing N6 in Ballybrit under a medium growth scenario compared with the ‘Do-Minimum’ scenario, along with reduced traffic at the Lynch Junction and Ballybrit Crescent Junction in Briarhill, and at the junction between the existing N6 and the R446 at Doughiska. At all these locations, there will be at moderate-significant positive impact on journey amenity. There will also be opportunities to provide improved facilities for the safety and journey amenity of pedestrians and cyclists.

For users of the proposed road development itself the journey amenity of drivers and passengers using the River Corrib Bridge will be enhanced by the view north and south along the river, including of the ruins of Menlo Castle. This represents a slight positive impact on journey amenity, but one realised by the large number of people using the proposed road development including tourists travelling west to Connemara.

General amenity

West of the Corrib

Traffic volumes on the section of the proposed road development to the north of Bearna are expected to be over 11,000 AADT under a medium growth scenario by the Design Year (2039), but will vary seasonally given summer tourism traffic. General amenity impacts relating to environment effects such as visual intrusion and noise are likely where residential properties are located close to the proposed road development, for example at the Cappagh Road Junction where private properties are located to the immediate north and south. These impacts are addressed in **Chapter 12, Landscape and Visual** and **Chapter 17, Noise and Vibration**. A large increase in traffic volumes will occur on the Cappagh Road albeit from a low baseline level. This will affect the amenity of a small number of properties to the south towards the suburban residential area where the road is necessarily wider. A large increase in traffic volumes is also predicted for the Ballymoneen Road, north and south of the proposed junction.

No significant amenity impact at a community level is presented by the proposed N59 Link Road North and South from the proposed N59 Letteragh Junction. On the southern link, traffic is distributed onto several minor roads and the road itself is largely separated from residential development. The northern link connects with the N59 Moycullen Road immediately to the north of Bushypark Church.

St. James’ School in Bushypark is located a short distance to the south of the proposed road development, but the school lies outside the proposed development boundary. There will be a slight residual negative general amenity impact on use of the playing ground due to the traffic noise, although this will be mitigated by screening. The remaining houses in the estates at Ard na Locha and Aughnacurra will incur an amenity impact due to the proximity of the proposed road development (see **Chapter 17, Noise and Vibration**).

There is a negative general amenity operational impact to the east of the N59 Moycullen Road where the proposed road development will be elevated above the NUIG Sporting Campus on a viaduct prior to the crossing of the River Corrib. Whilst the provision of a viaduct structure will provide access to the north and south of the Sporting Campus and the River Corrib during the operational phase, maintaining connectivity and permeability beneath the proposed road development, the NUIG Sporting Campus will require a new Sporting Campus Plan and Strategy. A best fit analysis was undertaken as part of the assessment which identified the possible reconfiguration of the Sporting Campus, part of which includes the replacement of the two pitches with a a floodlit 3G sports pitch and 3G training area and associated site infrastructure such as ball netting (refer to **Chapter 15, Material Assets Non-Agriculture**). From an amenity perspective there is also a negative impact on visitors to Menlo Castle on the east bank of the river. The positive impact on journey amenity for drivers on the proposed road development must also be acknowledged in this context.

East of River Corrib

To the south of the N84 Headford Road junction, a 38% increase in traffic is predicted to the Kirwan Roundabout, representing a moderate negative amenity impact, noting also the presence of Saint Francis National School and Ballinfoyle Church on this road. Additional pedestrian crossings have recently been provided on the N84 Headford Road.

Whilst there is no direct impact on Castlegar National School, the school does have an autistic facility which would be sensitive to traffic noise (see **Chapter 17, Noise and Vibration** and **Section 18.5.5** below). The proposed road development will have a positive impact by reducing traffic volumes on School Road, Castlegar, which, along with Bóthar an Chóiste, is currently used by morning and evening commuters as a rat-run (see **Section 18.5.4.4** below). Spellman's Boithrín is currently unsurfaced and in poor condition, but forms part of a circular walk that is used daily for access to the school. The nearby Hynes' Boithrín will be severed, but mainly provides only farm access to fields. Alternative access will be provided from School Road, Castlegar to these farm lands. (see **Chapter 14, Material Assets Agriculture**).

At the Parkmore Link Road, east of the N83 Tuam Road, a crossing point is included in the design of the proposed road development to allow for an historic mass path connecting Castlegar and the small community of Parkmore and a historic graveyard to a mass rock beside Galway Racecourse (see **Chapter 13 Archaeology, Architectural and Cultural Heritage**). Only light use is made of the path, but it is well maintained by the local community. There will be a significant negative residual impact on amenity use of the path compared with the existing environment due to the extensive new road network.

The proposed location of the Galway Racecourse Tunnel means that there will be no direct amenity impacts on the racecourse racing events during operation. New permanent access will be available to the N83 Tuam Road via the Parkmore Link Road and much improved access will be possible from the existing N6 such that the net impacts will be positive.

18.5.4.4 Community severance

Distinct physical severance is presented by two permanent road closures proposed along the length of the proposed road development. The first of these is at the northern end of Anne Gibbons Road in the western section of the study area. For most local residents, the severance impact is only slight, but occupants of properties closest to the proposed road development would entail a diversion to the south before returning north on the Bearna to Moycullen Road. Hynes Boithrín will also be severed, but currently provides access solely to fields and some amenity use.

West of River Corrib

The proposed road development will result in a projected reduction in traffic volumes in the east of Bearna Village by over 73% in the Design Year (2039) under a medium growth scenario compared with the 'Do-Minimum' Scenario. This will have a significant positive impact in terms of relief from severance especially away from crossing facilities during peak periods. This significant positive impact applies especially to the use of community facilities. A positive impact will also apply to the Church of Mary Immaculate and to Bearna Primary School on the R336 to the east of the village. Although there are tentative plans for the school to transfer to a new location at some time in the future, most parents must currently drop off their children at the roadside.

To the north, there will be an impact on neighbourhood or social severance as the proposed road development runs between residences at Na Foraí Maola. A similar impact can be anticipated on the Troscaigh Road where there is another cluster of residential properties. A degree of physical severance will arise from the additional distance required to reach the proposed overbridge at Ch. 1+375 from either location, particularly for local residents walking to nearby friends or family. However, the new connectivity provided between the two settlements also provides for relief from severance as currently there is no physical connection between the two communities. A significant impact will arise from the severance of the Ann Gibbon’s Road. This will require residents at the northern end of the road to access locations to the north by detouring 800 metres south to the junction with the Bearna Moycullen Road. Most traffic on this road heads south into Bearna Village, but some of residents also travel north to enter the city via Paddy’s Cross and Rahoon Road.

Elsewhere in this area, to mitigate physical severance, crossing facilities for pedestrians have been included in the design of the proposed road development where junctions exist. There will be a residual level of social severance for scattered communities and housing to the north of the proposed road development as many people express a sense of attachment to Bearna Village.

At Cappagh Road there are properties on either side of the proposed junction, but physical severance will be slight as crossing facilities are available. However, traffic volumes are expected to increase to the south of the junction, potentially affecting access to pitches located to the west of the Cappagh and presenting a slight negative impact, mainly for cyclists given the presence of crossing facilities.

The N59 South Link Road will connect to the Western Distributor Road via Millars Road in Gort na Bró Road. As a result, there will be additional traffic on this road, but this represents only a slight new severance impact on the Gaelscoil Mhic Amhlaigh and Millars Lane soccer pitches, both of which are already well-serviced with pedestrian crossing facilities. New residential development is also proposed for this location. The N59 Link Road North avoids any severance impact until its connection with the N59 Moycullen Road just north of St. James’ Church in Bushypark. Most access to the church is by car and traffic volumes are only predicted to increase slightly, although a footpath does run along the western side of the N59 Moycullen Road and signalised crossing facilities are proposed for the junction between the N59 Link Road North and the N59 Moycullen Road.

The elevation of the proposed road development above playing fields at the NUIG Sporting Campus provides no direct physical severance impact, but rather an impact on amenity. Traffic volumes are predicted to reduce slightly in the Design Year compared with a ‘Do-Nothing’ scenario on Thomas Hynes Road and Newcastle Road, but no significant change in existing severance is anticipated.

East of River Corrib

The proposed road development will introduce a degree of social severance between the small historic community of Coolagh and Menlough to the north. To the east, at the N84 Headford Road Junction, there will be moderate physical and social severance due to the presence of the junction. Physical severance along the N83 is already high due to current traffic volumes, although any new severance is minimised by the inclusion of signalised crossings at the slip roads to the proposed road development. Some new severance can be expected on the Headford Road south due to the increased traffic volumes that are predicted into the city.

No significant severance will be experienced in Castlegar, including for students at Castlegar National School, local residents or for visitors to the new nursing home. Commuting traffic using School Road, Castlegar as a ‘rat run’ is expected to be reduced due to the availability of the proposed road development. To the east at the proposed N83 Tuam Road Junction there is social severance between a line of private properties in Two-Mile-Ditch on the road to the north of the junction and the community of Castlegar. Current pedestrian journey amenity is poor in this area and will be slightly improved by the inclusion of a footpath in the design. Any severance of the Lisheen (fort) at Parkmore east of Galway Racecourse during the construction phase will be mitigated in the operational phase by the new access road and parking provided to the south of the proposed road development.

Refer also to **Table 18.14** and **Table 18.15** which summarises socio-economic impacts, mitigation measures and residual impacts in relation to severance during operation.

18.5.4.5 Economic

The proposed road development will deliver a profoundly positive impact for the Galway economy due to improved accessibility and connectivity for commerce, goods movement and commuters. There will also be positive impacts for communities in the west of the county for whom there will be improved connectivity to the east of Country Galway. There will be improved accessibility for very many businesses, but also direct and indirect negative impacts on others due to the route of the proposed road development.

West of River Corrib

Some loss of passing trade can be expected for a few businesses in Bearna and on the R336, including a small service station due to the transfer of traffic from the R336 to the proposed road development. As local traffic is expected to remain on the existing road these impacts will be slight.

The N59 Link Road North and South will provide much improved access for both customers and deliveries to the Gateway Retail Park and to business parks located off the N59 Moycullen Road and Newcastle Road Upper. Some of the congestion in the vicinity of Browne Roundabout and along Seamus Quirke Road will be relieved benefitting retail and other businesses in these locations. This improved access represents a significant positive impact.

East of River Corrib

Lackagh Quarry is no longer an active quarry. However, there are quarry reserves in the upper benches, some of which will be sterilised as a result of the proposed road development (refer also to **Chapter 9, Soils and Geology**). On the east side of the N84 Headford Road, improved new access will be provided to one commercial business property, although construction works will impact on part of the business' raw material source (see **Section 18.5.3.5**). This impact will be addressed as part of the land acquisition process and financial compensation.

At the N83 Tuam Road, whilst the proposed road development will present some temporary visibility impacts on a car dealership during construction (see **Section 5.3.5**), it will be provided with improved and safer access to the business from the City North Business Park Link in the operational phase. The proximity of the business to the proposed road development will also be a positive factor for familiarity and accessibility. The improved access to the An Post sorting centre located here represents a significant positive impact for this business.

The proposed Parkmore Link Road will provide new access between the N6 and N83, including use of Morris Junction. Currently the only access to the numerous business parks in the area is from the existing N6 and as a result there is major congestion occurring on a daily basis, particularly during peak hour traffic. Consequently, the new link road will provide a profoundly positive economic impact by facilitating connectivity and accessibility for deliveries to numerous businesses and for employees. This link road will also facilitate the provision of the walking, cycling and bus routes as set out in the GTS for the Ballybrit, City East and Parkmore Industrial estates, with the added health benefits of being able to walk or cycle to work.

The Parkmore Link Road will make use of an existing cul-de-sac access road serving Hewlett Packard and Boston Scientific. Boston Scientific recently acquired lands to the east of the existing IDA road comprising the former APC site, a total area of 12.6 hectares. The alignment of the link road has been designed to take account of Boston Scientific's plans to expand the existing facility and utilise the acquired APC site. This expansion involves the redevelopment of the existing buildings and their integration with the new facilities within the APC site. The first phase of the expansion plans includes the construction of a building immediately adjacent to and interlinked with the existing northern building. This will allow product and people to move throughout the expanded site without the need to move from a controlled sterile environment. Elsewhere, it will be necessary for vehicles and workers to cross the link road to access other parts of the landholding that are included in future phases of the expansion plans. Through traffic on the Parkmore Link Road will interrupt the movement of product and people within the Boston Scientific campus. A negative impact can be expected due to severance, but the proposed Parkmore Link Road itself will have a net positive impact by providing a direct transport link, which will be well serviced by public transport between the Parkmore and Ballybrit Business Parks, the N83 Tuam Road, the existing N6 and the proposed road development.

The proposed road development will pass below the Galway Racecourse in a dedicated tunnel. Some modest net loss of car parking is likely, but new permanent stables and facilities will be provided to replace those demolished during construction. These stables and facilities will need to be of an equal or higher standard to the existing buildings. Event day access is already available to the N83 Tuam Road, but this access will be much improved due to the Parkmore Link Road. When all measures are realised, a net positive economic impact can be anticipated.

By improving access between the existing N6 and the business parks in this area, the proposed road development will reduce congestion at Ballybrit Crescent Junction and Lynch Junction and this will have a positive impact on access to businesses at this location. This improved accessibility will apply also to a car dealership on the edge of Briarhill Business Park, although this may be accompanied by some loss of customer parking space and the presence of an elevated section of the proposed road development which will affect visibility from Ballybrit Crescent. The dealership's visibility to the east will be reduced, but it will remain very visible from the existing N6 and highly visible from the proposed road development. A positive impact will derive from the effect of reduced congestion at the Ballybrit Crescent Junction.

18.5.4.6 Tourism

Once operational the proposed road development will provide for improved connectivity between the important tourism destinations of Connemara and West County Galway and points of arrival to the east. This will help to sustain tourist numbers and to provide new tourism development opportunities while contributing to the economic development in a peripheral economic region. The proposed road development will enter an attractive rocky area west of the River Corrib that is typical of Connemara. This landscape therefore represents a gateway to the West. Visitors will quickly experience this setting following the elevated vista of the river. At present, this landscape is only encountered west of Bearna. Overall, the proposed road development's contribution to tourism represents a very significant positive impact.

A significant positive impact also arises from the reduction in congestion along the existing N6 and other roads into Galway City due to the transfer of a proportion of traffic to the proposed road development. This will also contribute to making the city more accessible, encouraging visitors to County Galway and the West to travel into the centre of the city to see attractions with less anxiety over traffic conditions. Combined with the potential for the reallocation of road space to pedestrians and cyclists provided by the GTS, this will contribute positively to the tourism experience in Galway. A positive introduction to Galway will also be provided by the new crossing of the River Corrib which will enhance journey amenity and encourage people to visit this part of the city's fringe. Improved access to the Galway Racecourse, including from the north, could also help to stimulate event attendance.

18.5.4.7 Ecosystem Services

There are no impacts identified which would result in a significant residual impact on ecosystem services during the operation of the proposed road development.

18.5.4.8 Summary

The operational phase will provide for significant, and in some cases very significant or profound, positive impacts on journey time, connectivity and journey amenity affecting journeys for all purposes and benefitting people living in the city or in its outskirts, businesses and visitors or tourist traffic. Particular positive impacts apply to the new connectivity between the existing N6 and N83 Tuam Road, improved connectivity for people living in rural areas in the west of the study area, and to reduced congestion along urban parts of the existing N6. The improved connectivity to West County Galway will stimulate economic development in this region, strengthening the integrity of the Galway Gaeltacht and the Irish language. The transfer of a proportion of through traffic will benefit people living in the vicinity of the existing N6 and provide an opportunity to improve additional public transport and facilities for pedestrians and cyclists under the Galway Transport Strategy. There are some negative impacts in terms of social severance (but less so physical severance) and the general amenity of people living in rural areas near the proposed road development to which they might have been attracted by the prevailing peacefulness of the surroundings. There will be very significant impact on the NUIG Sporting Campus as a result of the proposed road development. A flood lit 3G sports pitch and 3G training pitch and associated site infrastructure such as goal post netting will replace the lost pitches, but a new Sporting Campus Plan and Strategy will be required (refer to **Chapter 15, Material Assets Non-Agriculture**). Overall, the net effect of socio-economic aspects relating to Human Beings is assessed to be a distinct positive impact.

18.5.5 Irish Language - Potential Construction and Operational Impacts

There is a low-level of daily Irish usage among the population of the area directly affected by the proposed road development, and where it exists, the use of Irish is particularly concentrated in an education context. While population is increasing; the use of Irish-language is not growing in parallel. The proposed road development will not have any significant impact on the use of Irish into the future. However, it is noted that an improved road network would facilitate further migration and economic growth into the wider Galway Gaeltacht and as the west of County Galway have higher levels of unemployment and deprivation than the areas around Galway City, the proposed road development, by improving access to employment opportunities to the east of the city, will facilitate Irish speakers to commute more easily from their own communities and lessen the need to re-locate for economic reasons. Equally the proposed road development will make Gaeltacht areas to the west of Galway City more attractive for residential and commercial development as a result of a greatly improved road network. In this context, it will be the responsibility of Galway County Council, Galway City Council and Údarás na Gaeltachta among others to ensure that the use of the Irish language is promoted and encouraged among new residents.

Amongst the guiding principles that inform the proposed Gaeltacht Plan (Galway County Council 2017) is that the Planning Authority will “support an appropriate level of services and infrastructure to support existing and future growth and sustainable development in a manner that protects and is complementary to the environment, heritage, character and amenities of the Gaeltacht villages.”

In the course of consultation undertaken for this assessment, Údarás na Gaeltachta have indicated that they are in favour of the development of the N6 Galway City Ring Road (GCRR) around Galway City as it will “give more efficient access to the Gaeltacht area and the Connemara area west of the city". Údarás na Gaeltachta[25] stated that the new road would have a "very beneficial impact effect" on attracting new industries to the Gaeltacht and Connemara area, encouraging existing business to expand and would support existing businesses to have a more efficient access to their markets and personnel. Overall, it is considered that the proposed road development will have a positive impact on the economic and social viability of the entire Gaeltacht area.

In conclusion, the proposed road development will have a *Moderate Positive Impact* on the status of Irish as a community language within the Galway Gaeltacht area.

18.5.6 Human Health - Potential Construction and Operational Impacts

This section addresses health impacts under three main headings as per the methodology discussed in **Section 18.2.5.4 - Health Protection**, **Section 18.2.5.5 - Health Improvements** and **Section 18.2.5.6 - Improving Services**. Health protection covers the health effects of the proposed development arising from noise, vibration, air emissions, water and soil contamination and psychological issues. These are all discussed further below.

18.5.6.1 Health Protection

Noise

It is noted that despite the extents of the proposed road development and the overall construction period, the potential noise impact on any individual receptor during construction will be limited as the activity in any one location will be limited in scale and time. Thus, the potential for human health effects will be similarly limited.

The potential noise impacts are assessed in **Chapter 17, Noise and Vibration** in accordance with the relevant NRA Guidelines. The results of the baseline noise monitoring and potential impacts which are described in full in **Chapter 17, Noise and Vibration** have been compared against the relevant noise guidelines to determine if any human health effect is likely.

As discussed previously in **Section 18.2.5.4**, the potential health effects of noise can include

- Noise-Induced Hearing Impairment
- Interference with Speech Communication
- Disturbance at schools
- Sleep Disturbance
- Hypertension and Cardiovascular Disease

[25] Correspondence from Tadhg Ó Conghaile, Stiúrthóir Forbatha Réúigiunach Pobail & Pleanála Teanga, Údarás na Gaeltachta, dated 21 December 2017

As noted in **Section 18.2.4.5**, any effects demonstrated are more likely at higher noise levels. Many effects are only demonstrated with ambient noise in excess of 70dB. The results of the noise assessment detailed in **Chapter 17, Noise and Vibration** indicate that there is no receptor which will receive this volume of noise for any sustained period therefore health effects of noise from the proposed road development will not be significant. This is discussed further below.

<u>Construction Phase</u>

The noise assessment detailed in **Chapter 17, Noise and Vibration** identified that during the construction phase of the proposed road development there is potential for some temporary moderate to significant impacts on nearby residential and business properties due to noise emissions from certain construction activities. The application of binding noise limits and hours of operation, along with implementation of appropriate noise control measures, will ensure that potential noise impacts are kept to a minimum. As detailed in **Section 7.6.2** of **Chapter 17, Noise and Vibration** the construction contract documents will clearly specify the construction noise criteria which the construction works must operate within which align with the Schedule of Commitments included in the CEMP in **Appendix A.7.5**. The Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of *BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Noise* and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001 and the NRA *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes* 2013. Therefore, significant noise impacts during construction will not arise and no adverse health effects are predicted during construction.

<u>Operational Phase</u>

The noise assessment for the operational phase of the proposed road development indicates that without mitigation measures the potential noise levels at a number of receptors exceeded the specified noise mitigation criteria and necessary mitigation measures have been specified. Once such measures are implemented, it was shown that the vast majority of locations comply with the adopted criterion. For those minor areas which do not meet the design goal, the predicted noise level for the operational phase is within 3dB of the design goal or less than the predicted noise level in the do-minimum scenario.

Many properties along the existing roads that currently experience high levels of traffic will experience a notable reduction in noise levels depending on the distance from the road, traffic volume changes and speed reductions.

Baseline noise levels are important to consider when assessing human health impacts. Human perceptions of sound intensity are such that changes of less than 3dB are usually not perceived. If noise levels do not increase by at least 3dB there will be no adverse outcome over than experienced prior to the change. In this regard a threshold of 3dB is appropriate to identify a change in noise levels which can be reliably perceived by humans.

As mentioned earlier the WHO night time noise guidelines are for communities rather than individual residences and in addition it is important to remember that the levels are not thresholds. Nevertheless, individuals will always be concerned with the potential effects on them and therefore, it is useful to use these levels in attempting to attribute significance to changes in noise levels.

The significance of human health impacts as per the criteria referred to above in **Table 18.7** are as follows:

- If the L_{night} immediately outside a residence is below 55dB the Human Health impact is Imperceptible
- If the existing L_{night} immediately outside a residence is below 55dB and it increases by more than 3dB but remains below 60dB the Human Health impact is Slight Negative
- If the existing L_{night} immediately outside a residence is below 55dB and it increases by more than 3dB and to a level above 60dB the Human Health impact is Moderately Negative.

As mentioned above the proposed road development, by diverting traffic away from heavily populated areas overall has benefits in terms of community night-time noise. Therefore, the overall health effect would be positive. However, this is of little comfort to individuals who actually experience an increase in noise and the potential noise impacts on individual properties have been assessed and mitigation measures proposed in **Chapter 17, Noise and Vibration**.

Site Specific Operational Noise Impacts

Ch. 0+000 to 2+800 (R336 to Bearna East Roundabout)

The vast majority of receptors are below 55dB L_{night} in this area. At Bearna West Roundabout there is only a predicted increase of 1dB over the 'Do-Nothing' scenario at levels above 55dB L_{Night}. Therefore, no negative human health impacts are predicted.

Ch. 2+800 to 7+600 (Bearna East Roundabout to N59 Letteragh Junction)

All receptors are below 55dB L_{Night} in this area. Therefore, no adverse human health impacts are predicted.

Ch. 7+600 to 9+300 (N59 Letteragh Junction to River Corrib Bridge)

The vast majority of receptors are below 55dB L_{Night} in this area. At Bushypark along the N59 Moycullen Road where levels are above 55dB L_{Night}, there is only a predicted increase of 1dB over the 'Do-Nothing' scenario. In addition, some of the receptors around the N59 Moycullen Road are predicted to have L_{Night} above 55dB but there is relatively little change from the 'Do-Nothing' scenario with no increase in excess of 2dB. Therefore, no adverse human health impacts are predicted.

St James's School at Bushypark is not identified as having any significant negative impact.

Ch. 9+300 to 12+100 (River Corrib Bridge to N84 Headford Road Junction)

The vast majority of receptors are below 55dB L_{Night} in this area. Any that are above this level show little of no change from 'Do-Nothing' Scenario. Therefore, no negative human health impacts are predicted.

Ch. 12+100 to 14+000 (N84 Headford Rd Junction to N83 Tuam Road Junction)

The vast majority of receptors are below 55dB L_{Night}. At the N83 Tuam Road Junction where predicted levels are above 55dB L_{Night}, there is only a predicted increase of 1 or 2dB over the 'Do-Nothing' scenario. Therefore, no negative human health impacts are predicted.

Castlegar National School and the associated Beoga Pre-school are not identified as having any significant negative impact. This is of particular significance given the specific facilities at Castlegar School for children suffering from Autistic Spectrum Disorder.

Ch. 14+000 to 17+500 (N83 Tuam Rd Junction to Coolagh Junction)

The vast majority of receptors are below 55dB L_{Night} in this area. While some receptors are predicted to be above 55dB L_{Night}, there is only a predicted increase of up to 3dB, but not over 3dB, over the 'Do Nothing' scenario in those cases.

The Galway Clinic does go above 55dB L_{Night} but as mentioned the change is only 3dB. This is less than the more than 3dB threshold mentioned above so the impact on the Galway Clinic is assessed as Imperceptible. Therefore, no negative human health impacts are predicted.

Overall using the criteria for the significance of human health impact detailed in **Table 18.6** the impact rating in relation to noise is slight and no negative human health impacts are predicted.

Vibration

The potential vibration impacts as a result of the proposed road development both during construction and operation have been assessed in **Chapter 17, Noise and Vibration**. Overall the predicted impact from vibration is very low and characterised as not significant. While there may be some degree of local vibration transmitted during some aspects of construction, such as blasting or drilling, these will typically be of short duration and very localised and occur only during construction hours. Given the short duration it will not have any negative health impacts.

The potential vibration impact during the operational phase as detailed assessed in **Chapter 17, Noise and Vibration** is predicted as being not significant. Therefore there will be no negative health impacts.

Using the criteria for the significance of human health impact detailed in **Table 18.6** above the potential impact caused by vibration is assessed as Imperceptible.

Air Quality

As discussed previously in **Section 18.2.4.5**, provided the air quality standards are not exceeded one can be confident that there will be no adverse effect on human health due to air emissions. This is discussed further below.

As is detailed in **Chapter 16, Air Quality and Climate**, certain sensitive receptors have been identified in the study area for the proposed road development and dusts that are likely to be generated during the construction phase are normally heavier and larger particles. As these are heavier, they tend to fall rapidly to the ground and have a very limited level outside the actual construction site. There are potential occupational health issues for the works which would require for example the use of respiratory protection equipment in certain phases. However, as also pointed out in **Chapter 16, Air Quality and Climate**, in the event of such large dust leaving the site, by nature of its' relatively large size, that is greater than 10 microns, it is not respirable and will not have significant human health effects.

It is also noted that despite the extents of the proposed road development, the potential air quality impact on any individual receptor will be limited as the activity in any one location will be limited in scale and time. Thus, the potential for human health effect will be similarly limited.

The potential air quality impacts are assessed in **Chapter 16, Air Quality and Climate** in accordance with the relevant TII Guidelines. The results of the baseline air quality monitoring and potential impacts which are described in full in **Chapter 16, Air Quality and Climate** have been compared against the reliable air quality standards both during the construction and operational phases to determine if any health effect is likely.

The proposed road development is predicted to have a negligible impact on air quality, as defined in **Chapter 16, Air Quality and Climate**[26], across the study area during the construction phases and as such an imperceptible impact on human health. Whilst some areas of the study area will l experience a slight negative impact on air quality during the operational phase all air quality levels will remain well within air quality standards and as such there will be an imperceptible impact on human health. Site specific impacts during operation are further detailed below.

<u>Site Specific Operational Air Impacts</u>

Ch. 0+000 to 5+650 (R336 to Ballymoneen Road Junction)

These areas are predicted to have a negligible[26] air quality impact during the operational phase and therefore there will be no health effect.

Ch. 5+650 to 7+600 (Ballymoneen Road Junction to N59 Letteragh Junction)

This area is identified as having a slight negative impact at the N59 Moycullen Road in terms of NO_2 in the operational phase but this is a relative increase only and all levels remain well within air quality standards. All other impacts on air are assessed as negligible and therefore there will be no health effect.

Ch. 7+600 to 9+300 (N59 Letteragh Junction to River Corrib Bridge)

This area is predicted to have a negligible[26] air impact during the operational phase and therefore there will be no health effect.

Ch. 9+300 to 12+100 (River Corrib Bridge to N84 Headford Road Junction)

Some receptors in this area are identified as having a slight negative impact in terms of NO_2 in the operational phase but this is a relative increase only and all levels

[26] Where the impact magnitude of the changes in concertation of PM_{10} is imperceptible, then the impact description is negligible.

remain well within air quality standards. All other impacts on air are assessed as negligible[26] and therefore there will be no health effect.

Ch. 12+100 to 14+000 (N84 Headford Rd Junction to N83 Tuam Road Junction)

Some receptors in this area are identified as having a slight negative impact in terms of NO_2 in the operational phase but this is a relative increase only and all levels remain well within air quality standards. All other impacts on air are assessed as negligible[26] and therefore there will be no health effect.

Ch. 14+000 to 17+500 (N83 Tuam Rd Junction to Coolagh Junction)

This area is predicted to have a negligible[26] air quality impact during operational phase and therefore there will be no health effect.

Water

As is identified in **Chapter 10, Hydrogeology** and **Chapter 11, Hydrology** no negative impact from either surface water, or groundwater is anticipated. In this regard human health effects will not occur.

The hydrogeology assessment concluded that given the mitigation proposed there is a slight residual impact from the proposed road development with respect to groundwater quality as a resource. In terms of the quantity of groundwater available within the aquifer (the yield of the resource) there will be an imperceptible effect at the regional scale. It did state that some individual wells will be affected in terms of flow or water quality, however there will be no impact in potable water quality as alternative supplies will be utilised if necessary. At all times water quality standards will be observed to ensure public health.

In addition, the River Corrib is the main source of water for the city of Galway. Abstraction of the water is located 1.7km downstream from the proposed River Corrib Bridge and therefore at risk to pollution from the proposed road development, particularly during the construction phase. Stringent mitigation and control of potential polluting activities associated with construction activities will be implemented which will significantly reduce the risk of impact.

The operational phase also presents a pollution risk to this supply both from accidental spillages and from routine road run-off discharges. Design pollution control measures have been put in place to reduce the risk.

Given that all residual water supplies will comply with water quality standards the potential impacts on human health are assessed as Imperceptible.

In addition, in the broader context, the flood risk assessment has demonstrated that there is no significant flooding impact arising from the proposed development and hence no potential impact on human health.

<u>Water quality</u>

As detailed in **Chapter 10, Hydrogeology** and **Chapter 11, Hydrology**, there has been considerable attention given to ensuring that there will be no adverse effect on water quality. Where necessary mitigation measures are put in place to ensure continued supply of high quality and safe drinking water. The vast majority of residences in the area receive their water by mains which will continue to be monitored in the normal way.

No adverse effect on water quality is predicted and therefore there will be no health effect.

Flooding

The design of the construction and operational phase of the proposed road development has considered the risk of flooding at every step. This applies particularly of course to the area in the immediate vicinity of the River Corrib. The design of the construction of the River Corrib Bridge and ancillary works will ensure that there is no increased risk of flooding and indeed flood protection measures have been included and therefore there will be no health effect.

Soils

Soil Contamination

As detailed in **Chapter 9, Soils and Geology** there are no known areas of contaminated lands crossed by the proposed road development. While it is not anticipated that any of the construction or operational works would lead to soil contamination the contractor will be obliged to monitor the construction at all stages. In the event that any source of contamination is identified, in excavation or other means, this would have to be addressed at that time in consultation with statutory bodies such as the EPA. This will ensure that even in the unlikely event a source of contamination is discovered that appropriate mitigation measures will be put in place to ensure no adverse effect on human health.

Radon

The area of Galway which the proposed road development traverses is in a high radon area. As noted previously in **Section 18.2.5.7**, it is only when radon builds up in buildings that are inhabited by human beings that the health risk occurs. During construction, there will be excavations and tunnelling activities. This will have the potential to cause some release of radon. However, this will almost instantaneously be dissipated and will be harmless. Radon escape from rock will take the path of least resistance. Radon is escaping all the time but when it escapes to the open air there are no health effects.

The excavation and tunnelling activities will, if it has any effect at all on radon, and it is most likely that it will have none, actually divert radon away from residences rather than towards them as the radon may find an easier route to surface via the excavations rather than its current route. That is people which may be at risk because they live and work in a high radon area, will be not be at a higher risk because of the proposed construction or indeed operation of the proposed road development.

The potential human health impact of the construction and operational phases of the proposed road development with regards to radon are assessed as imperceptible.

Psychological

As set out in **Chapter 15, Material Assets Non-Agriculture**, the proposed road development has been designed to avoid as many properties as possible but given the built environment and the linear development of the city with housing along every road radiating out of the city its construction will unfortunately and unavoidably result in a number of property acquisitions or demolitions. Numerous alternatives have been considered as detailed in **Chapter 4, Alternatives Considered**, however the conclusion of the consideration of the alternatives is that the proposed road development represents the optimum transport solution and has avoided the greatest number of known and immovable constraints and is the option that overall has the least environmental impact taking all other potential environmental impacts into account. The people living in these homes have genuine concerns that their lives will be adversely affected. Many have lived in the area many years or indeed all of their lives. In the event of an approval of the Protected Road Scheme and Motorway Scheme and approval under Section 51 of the Roads Act 1993 (as amended), by An Bord Pleanála and subject to the availability of funding, Notice to Treat will be served firstly on owners, lessees and occupiers of the dwelling houses and commercial properties to be acquired, within six months of the scheme becoming operative, unless an application has been made for Judicial Review, in which case the Notice to Treat[27] will be served in accordance with the provisions of Section 217 (6A) of the Planning and Development Act 2000 as inserted by the Compulsory Purchase Orders (Extension of Time Limits) Act 2010. Compensation will be agreed or determined by the property arbitrator as soon as possible after service of Notice to Treat. After compensation has been agreed or determined and satisfactory title has been produced, part payment can be made while the claimant remains for an agreed period in the property to be acquired. This will facilitate the claimant in removing uncertainty and will facilitate arrangements being made, as early as possible, to secure a replacement property.

The community will also experience annoyance from the temporary impacts of traffic management and other effects during the construction phase. As against this there is the potential reduction in annoyance amongst road users in the operational phase where there are reduced journey times.

Whilst individual annoyance cannot be discounted, annoyance in itself is not a health effect. There is no evidence that there are any significant effects on human health from simply transient levels of annoyance. In these circumstances the negative impacts is assessed at Slight. In addition, while there may be positive impacts of reduced annoyance for those not stuck in traffic there is little evidence of positive impacts on human health and the positive impact is assessed also as Slight.

It is worth noting that the proposed road development will remove a lot of congestion from the city centre and the potential for conflict between vehicular traffic and pedestrians and cyclists, thereby reducing the potential number of collisions and possible fatalities. Not only would the avoidance of fatalities and

[27] This notice requests landowners to submit their claim for compensation for lands being taken under the Protected Road Scheme or Motorway Scheme. This is the initial step in the acquisition of property and lands.

serious injuries have a very significant positive impact on an individual basis, any such injury or fatality would have a huge adverse impact on the individual's family, friends and colleagues such as that there can be a wider impact on the psychological health of the community.

The Do-Nothing scenario has potential for adverse psychological impacts. Progressively longer journey times and uncertainty will be associated with increased annoyance at least and at worst impact on psychological health.

As detailed in **Section 18.5.3** and **18.5.4** the proposed road development will cause a degree of physical and social severance. Where severance does occur there is potential for psychological impact. Loneliness can occur if someone feels cut off for example. As against this there may be positive psychological effects where improved connectivity permits greater ease of movement around the city. This would potentially facilitate closer connections with friends or relatives which might be deterred if journeys were perceived to be lengthy or difficult.

Overall, therefore, the assessment of the psychological impact on a population of community basis will be overall positive. However, one cannot escape the fact that certain individuals particularly those whose homes are to be compulsory acquired may not experience the community benefit.

18.5.6.2 Health Improvement

As detailed in **Section 18.5.3** and **18.5.4**, the proposed road development has the potential to bring with it, significant socio-economic benefits. It will facilitate transport of goods and people in a timely, reliable and efficient manner. The full economic benefit will be realised once the proposed road development is completed. Accessibility to businesses and community facilities in Galway City and its environs and the Business Parks in Parkmore and Ballybrit will be better facilitated by the proposed road development and the resulting reduction in congestion. It will also bring with it benefits to business and public facilities in Galway City centre by reducing noise and air pollution. This all translates into an increased potential for economic prosperity for the Western Region, with Galway City as a thriving city at the core, which in turn will play a part in reviving the Irish economy.

Whilst the benefits are applicable to Galway City and County, it may be particularly felt in the West of Galway. As was identified earlier in this chapter, the deprivation map detailed in the HSE Health Profile for County Galway identifies many of the most deprived areas of Galway County as being to the west of the city in Connemara. These areas are amongst those most likely to get a socio-economic benefit from the proposed road development. As set out in **Section 18.2.5.5** an improvement in socio-economic circumstances can contribute to improving the health and wellbeing of socio-economically deprived communities. It therefore follows that the socio-economic benefits of the proposed road development will also contribute to health benefits.

The provision of an additional crossing of the River Corrib will facilitate the reduction of congestion on city centre roads, and allow the reallocation of road space in the city network to non-motorised modes of transport, thereby facilitating the effective implementation of all the elements contained in the Galway Transport Strategy, namely the improvement of public transport, cycling and walking measures and provides the opportunity for health improvements.

As detailed in **Chapter 3, Need for the Proposed Road Development**, the proposed road development will enable the reallocation of existing road space within the city to public transport and smart mobility measures and as such facilitate the full implementation of the GTS. It will facilitate a more efficient public transport system and provide for of a multi-modal choice of travel including walking and cycling. Analysis of the traffic model shows a 21% increase in cycling with the full implementation of the GTS with a small decrease in walking largely due to people switching from walking to cycling or public transport, however, there will be an overall benefit in terms of opportunities to exercise and the associated health benefits. The increased opportunities to exercise due to an environment more amenable to walking and cycling, will also facilitate the social interaction among neighbours which may be currently be inhibited by excessive traffic all of which provide significant opportunities for health improvement.

Increased opportunities for exercise also has the potential to bring benefits in terms of human health. Exercise is a well-recognised method of reducing risk in terms of obesity, diabetes, hypertension, cardiovascular disease and osteoporosis amongst other conditions. There are also significant psychological benefits and studies have consistently shown self-reported well-being is significantly higher in those who frequently exercise.

One of the project objectives as set out in **Chapter 3, Need for the Proposed Road Development** is safety. The proposed road development is designed to optimal safety levels. It is well established that roads which are designed to safe standards are associated with reduced accident levels. The proposed road development also has the added benefit of moving the traffic away from pedestrian traffic reducing the opportunities for pedestrian injury or death. It introduces opportunities for safer travel for cyclists with the introduction of cycle measures included in the GTS.

The proposed road development would further improve access to health care through enhanced public and private transport connectivity, and may facilitate faster and safer emergency response through improved road capacity and resilience. Ambulances being able to get to an emergency situation in minutes as opposed to being delayed in heavy traffic has obvious benefits for health and could potentially be lifesaving. The study by Lyon et Al, referenced in the literature review in **Section 18.2.5.7**, reinforces this point by showing that there is an improved survival rate with out-of-hospital cardiac arrests with more rapid response times from the emergency services. This improvement is equally important in relation to the heading below under improving services.

18.5.6.3 Improvement of Access to Services

For vehicle drivers the ability to access services will be improved by the proposed road development. The diversion of traffic away from busy city centre streets will mean that people will be able to access shops, restaurants, cinemas and other services easier with less delays.

Similarly, for people needing to cross the city centre to access services, they will be facilitated by the proposed road development. This will be particularly so for those living on the west of the River Corrib. There will also be a more efficient and reliable connectivity to the national road network. This is particularly important in an Irish context as many major health services are situated in Dublin for example, the new National Children's Hospital.

There is also the potential for the proposed road development to improve access to services for non-motorised transport users to reach key services. As previously mentioned the diversion of traffic away from the city centre will facilitate public transport both in the form of buses and taxis. Reduction in traffic will also facilitate cycling and pedestrian access to services particularly around currently heavily used city streets.

It is clear therefore that with regards to access to services the proposed road development impact is overwhelmingly positive. That being said, certain individuals albeit very few, who are living or accessing areas in the immediate vicinity of the proposed road development, would for reasons of severance or road closures have to detour somewhat from their current routes. Once they do access the transport links, however, they too will benefit from improved access to services.

18.5.6.4 Summary

In summary, health protection covers the health effects of the proposed development arising from noise, vibration, air emissions, water and soil contamination and psychological issues. The results of the baseline noise monitoring and potential impacts set out in **Chapter 17, Noise and Vibration** have been assessed and no negative human health impacts are predicted as a result of noise emissions. The predicted impact from vibration is very low and characterised as not significant. Therefore, the potential impact caused by vibration is assessed as Imperceptible.

The proposed road development is predicted to have a negligible[28] impact on air quality across the study area during the construction phases and as such an imperceptible impact on human health. Whilst some areas of the study area will experience a slight negative impact on air quality during the operational phase all air quality levels will remain well within air quality standards and as such there will be an imperceptible impact on human health.

Given that all residual water supplies will comply with water quality standards the potential impacts on human health are assessed as Imperceptible. No adverse effect on water quality is predicted and therefore there will be no health effect. In addition, in the broader context, the flood risk assessment has demonstrated that there is no significant flooding impact arising from the proposed road development and hence no potential impact on human health. There are no predicted impacts on human health as a result of soil contamination or radon.

[28] Where the impact magnitude of the changes in concertation of PM_{10} is imperceptible, then the impact description is negligible.

The people living in homes to be acquired or demolished for the construction of the proposed road development have genuine concerns that their lives will be adversely affected. Many have lived in the area many years or indeed all of their lives.

The proposed road development will remove a lot of congestion from the city centre and the potential for conflict between vehicular traffic and pedestrians and cyclists, thereby reducing the potential number of collisions and possible fatalities. The proposed road development will cause a degree of physical and social severance. Where severance does occur there is potential for psychological impact. Loneliness can occur if someone feels cut off for example. As against this there may be positive psychological effects where improved connectivity permits greater ease of movement around the city. This would potentially facilitate closer connections with friends or relatives which might be deterred if journeys were perceived to be lengthy or difficult.

Overall, therefore, the assessment of the psychological impact on a population of community basis will be overall positive. However, one cannot escape the fact that certain individuals particularly those whose homes are to be compulsory acquired may not experience the community benefit.

The potential impacts of the proposed road development in the operational phase will be largely positive with significant opportunities for health improvements. These include, but are not limited, to improved access to services including emergency services, the potential for socio-economic development with the associated health improvements. The provision of an additional crossing of the River Corrib will facilitate the reduction of congestion on city centre roads, and allow the reallocation of road space in the city network to non-motorised modes of transport, thereby facilitating the effective implementation of all the elements contained in the Galway Transport Strategy, namely the improvement of public transport, cycling and walking measures and provides the opportunity for health improvements with the increased opportunities for exercise. The proposed road development would further improve access to health care through enhanced public and private transport connectivity, and may facilitate faster and safer emergency response through improved road capacity and resilience.

18.6 Mitigation Measures

18.6.1 Socio-economics

Specific proposed mitigation measures for potential socio-economic impacts are listed in **Tables 18.13** and **18.14**, many of which have been included in the design of the proposed road development. These include the provision of crossing facilities at the Foraí Maola Road, Troscaigh Road, Bearna to Moycullen Road L1321, Cappagh Road and Ballymoneen Road junctions to facilitate pedestrian and/or cyclist crossings of the proposed road development. Pedestrian crossing facilities are also proposed at the terminus of the N59 Link Road North Junction at the N59 Moycullen Road (Bushypark Junction) and at the slip road connections with the N84 Headford Road Junction. Cycle lanes are proposed to facilitate access to the Miller’s Lane pitches and Gort na Bró and at the N84 Headford Road Junction.

The following specific mitigation measures are proposed to improve journey amenity, amenity and minimise severance:

- Provide pedestrian crossing facilities at junctions with minor roads serving local rural communities
- Provide temporary visual screening from construction works at St. James' Church Cemetery in Bushypark and at St. James' School, Bushypark
- Provide pedestrian crossing facility at Bushypark Junction with N59 Link Road North during construction and operation
- Avoid any prolonged severance and minimise duration of use by construction traffic of An Seanbóthar
- Provide for alternative access along the bank of the River Corrib, along with prior advice for walkers, if access restrictions apply due to construction of the overhead bridge crossing
- Phase construction works to minimise impacts on racing events at Galway Racecourse
- Provide directional signage for access to car dealership and An Post sorting centre on N83 Tuam Road during construction
- Provide pedestrian crossing facilities at N84 Headford Road Junction during construction and operation
- Provide a footpath within the proposed development boundary along School Road, Castlegar
- Provide directional signage for a Briarhill Business Park, including a car dealership located here during both the construction
- Take measures to ensure that cul-de-sacs or adjacent lands are not used for illegal parking in the operational phase

Outside of the proposed development boundary associated with the proposed road development itself, it is recommended that the relevant authorities take measures to enhance the local connectivity provided and consequently its value and acceptability to the local community. Whilst not required as part of the proposed road development it will provide further benefits for the community. Such measures could include the widening of sections of narrow, currently substandard rural roads in the western section of the study area. The extension of public footpaths and cycle paths included in the design to ensure that these are not isolated, but provide connectivity to community facilities and other pedestrian and cyclist facilities.

The proposed road development will facilitate the implementation of the walking, cycling and public transport measures set out in the GTS. The transference of traffic from the existing N6 through Galway City to the proposed road development will provide an opportunity for improved pedestrian and cycle paths and crossing facilities, including continuity at major junctions and a modal shift to alternatives to the private car. Improved walking and cycling journey amenity is contingent on these appropriate facilities being provided. When implemented, such facilities will provide a significant improvement to pedestrian and cyclist journey amenity combined with reduced severance.

As discussed in **Chapter 15, Material Assets Non-Agriculture**, the proposed road development traverses the NUIG Sporting Campus on a viaduct. During construction, restricted access across the construction area at the NUIG Sporting Campus facilities will be maintained.

Alternative pitch facilities will be provided to replace the existing pitches directly impacted by the proposed road development. The facilities include a floodlit 3G GAA pitch and a floodlit 3G training area and associated site infrastructure for the drainage of these pitches and furniture such as ball-stop netting. The proposed road development also intercepts the existing sports pavilion resulting in direct impacts to its western end and the building will be modified as follows:

- the existing western plant room, 1 no. changing room, 1 no. storage area, 1 no. weights area and associated access hallways on both ground floor and upper levels will be demolished
- the western plant room and its associated plant will be relocated
- construction and reconfiguration of the internal and external walls, roof, windows and door locations

Temporary stables will be provided for Galway Racecourse during the construction of the proposed road development until such time as the Galway Racecourse Tunnel is complete and the permanent stables are constructed.

18.6.2 Irish Language

Mitigation measures proposed to protect the Irish Language are as follows:

- During construction, all public notifications and all public project updates are to be provided in both Irish and English languages
- While it is expected that day-to-day communications involved in the construction of the proposed road development will be through the English language, the Main Contractor shall have the capacity to communicate and correspond through the use of the Irish language and to devote adequate and proportionate staff resources to dealing with any individual wishing to correspond and communicate through the Irish language
- Placenames shall be cited in accordance with the relevant Placename Order issued under the Official Languages Act 2003

18.6.3 Human Health

Mitigation measures proposed for the potential air quality, noise, water and soils are specified in **Chapter 9, Soils and Geology**, **Chapter 10, Hydrogeology**, **Chapter 11, Hydrology**, **Chapter 16, Air Quality and Climate** and **Chapter 17, for Noise and Vibration** and the key mitigation measures which apply to human health are outlined below and are also in the respective chapters listed above. The implementation of these mitigation measures, emissions, including air and noise will be adequately controlled to ensure no adverse effect on human health.

18.6.3.1 Noise

The key noise mitigation measures include:

- Use of a Low Noise Road Surface
- Use of noise barriers as detailed in **Table 17.14**
- Control measures for construction works. Noise control measures that will be considered include the selection of quiet plant, enclosures and screens around noise sources, limiting the hours of work and noise monitoring. The contractor will be required to conduct construction noise predictions prior to works taking place and put in place the most appropriate noise control measures depending on the level of noise reduction required at any one location. The Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of *BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Noise* and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001
- Construction hours will mostly take place during daytime hours Monday to Friday. It will be necessary to work overtime (including weekends) and night shifts at certain critical stages during the project. Over the expected 36-month construction phase there will be up to 10 weeks of night-time working along different sections of the proposed road development primarily to facilitate bridge works over existing roads
- During the construction phase noise monitoring will be undertaken at the nearest sensitive locations to ensure construction noise limits outlined in **Table 17.1** of **Chapter 17, Noise and Vibration** are not exceeded. It is recommended that noise control audits are undertaken at regular intervals throughout the construction programme, as part of the noise and vibration management of the construction of the proposed road development which will be set out in the construction contract requirements
- In terms of blast design control, specific guidance will be obtained from the recommendations contained within *BS 5228-2:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Vibration* in relation to blasting operations in addition to experienced blast control techniques used by the contractor. Ref **Chapter 17, Noise and Vibration** for further details
- In the case of vibration levels giving rise to human discomfort, in order to minimise such impacts, the following measures shall be implemented during the construction period:
    - A clear communication programme will be established to inform adjacent building occupants in advance of any potential intrusive works which may give rise to vibration levels likely to exceed perceptible levels. The nature and duration of the works will be clearly set out in all communication circulars
    - Alternative less intensive working methods and/or plant items shall be employed, where feasible
    - Appropriate vibration isolation shall be applied to plant, where feasible

  - Cut off trenches to isolate the vibration transmission path shall be installed where required
  - In the case of impact piling or demolition works for instance, a reduction in the input energy per blow shall be considered where required
  - Monitoring will be undertaken at identified sensitive buildings, where proposed works have the potential to be at or exceed the vibration limit values

- Property condition surveys will be offered for all buildings within 50m of the proposed development boundary and those within 150m of proposed blasting works along the proposed road development. Property condition surveys will also be carried out at buildings and structures considered appropriate relative to their proximity to the works.

18.6.3.2 Air

The implementation of 'standard mitigation for air' as state in the TII Guidelines include:

- Spraying of exposed earthwork activities and site haul roads during dry weather
- Provision of wheel washes at exit points
- Control of vehicle speeds and speed restrictions. It is proposed that site traffic is restricted to 20km/hr. This will help to minimise the occurrence of dust re-suspension
- Sweeping of hard surface roads

In addition, the following measures will be implemented:

- A public communication strategy will be implemented by the Contractor which will outline procedures to inform members of the community on activities that may be disruptive, further details are contained in **Appendix A.7.5 Construction Environmental Management Plan**. This appendix also includes details of a complaints register which will be implemented during the construction phase
- Exhaust emissions from vehicles operating within the site, including trucks, excavators, diesel generators or other plant equipment, will be controlled by the contractor through regular servicing of machinery
- During dry periods when dust generation is likely or during windy periods, construction areas and vehicles delivering material with dust forming potential will also be sprayed with water, as appropriate
- Areas where materials will be handled and stockpiled will be positioned away from main site access roads. These areas will also be designed to minimise their exposure to wind – all stockpiles shall be kept to the minimum practicable height with gentle slopes
- There shall be no long-term stockpiling on site and storage time will be minimised

- Material drop heights from plant to plant or from plant to stockpile will be minimised
- Water suppression will be used during the demolition of buildings
- Crushing and concrete batching plant will be located as far from sensitive receptors as is reasonably practicable. All storage bins and transfer points will be covered. Silos will be fitted with reverse jet air filters
- Dust screens will be implemented at locations where there is the potential for air quality impacts during the construction phase, i.e. at locations where sensitive receptors are located within 100m of the works
- Employee awareness is also a most important way that dust may be controlled on any site. Staff training and the vigilant management of operations ensure that all dust suppression methods are implemented and continuously inspected
- Dust deposition monitoring will be conducted at a number of locations in the vicinity of the proposed road development. At a minimum, monitoring will be carried out at the two nearest sensitive receptors at locations where works of a ‘major’ scale is proposed while works are taking place in proximity, refer to **Section 16.5.3.1** of **Chapter 16, Air Quality and Climate**.

18.6.3.3 Water and Soil

The key water and soil measures to prevent pollution, flooding and soil contamination include:

- Measures have been incorporated into the design of the proposed road development will protect water quality and soils and also prevent any significant flooding, thus avoiding any potential health impacts
- During construction, the contractor shall implement the Construction Environmental Management Plan as set out in **Appendix A.7.5**

18.6.3.4 Demolitions and Acquisitions – Psychological Effects

In the event of an approval of the Protected Road Scheme and Motorway Scheme and approval under Section 51 of the Roads Act 1993 (as amended), by An Bord Pleanála and subject to the availability of funding, Notice to Treat will be served firstly on owners, lessees and occupiers of the dwelling houses and commercial properties to be acquired, within six months of the scheme becoming operative, unless an application has been made for Judicial Review, in which case the Notice to Treat[29] will be served in accordance with the provisions of Section 217 (6A) of the Planning and Development Act 2000 as inserted by the Compulsory Purchase Orders (Extension of Time Limits) Act 2010. Compensation will be agreed or determined by the property arbitrator as soon as possible after service of Notice to Treat. After compensation has been agreed or determined and satisfactory title has been produced, part payment can be made while the claimant remains for an agreed

[29] This notice requests landowners to submit their claim for compensation for lands being taken under the Protected Road Scheme or Motorway Scheme. This is the initial step in the acquisition of property and lands.

period in the property to be acquired. This will facilitate the claimant in removing uncertainty and will facilitate arrangements being made, as early as possible, to secure a replacement property.

18.7 Residual Impacts

18.7.1 Socio-economics

18.7.1.1 Journey characteristics

Once operational, the proposed road development will provide a very significant positive residual impact in terms of improved connectivity across and beyond the city, including to national roads via the junctions included as part of the proposed road development. This will maximise the transfer of cross-city movements to the new road infrastructure, thus releasing and freeing the existing city centre and inner suburbs from congestion caused by traffic trying to access a city centre bridge to cross the River Corrib. Residual impacts respective to each identified impact and impact type are listed in the final column of **Table 18.14** and **Table 18.15**.

18.7.1.2 Amenity

The proposed road development will have a positive residual impact on journey amenity on most city roads by encouraging a transfer of through and other traffic, reducing congestion particularly at major junctions. Some transference of traffic will occur to arterial roads connecting with junctions on the proposed road development, but overall the reduction in traffic on the major road arteries will provide a residual positive contribution to journey and general amenity in the city. There will be particular benefits for pedestrians and cyclists as the transfer of traffic will allow for an improvement in relevant facilities together with opportunities for more public transport as proposed in the GTS.

The pattern of residential development in the study area means that the construction of the proposed road development will impact directly on a high proportion of residential properties at several locations. There will be an inevitable very significant negative impact on most of the householders who are directly impacted by compulsory purchase. As the proportion of properties to be acquired or demolished at three locations is high in relation to the total number of properties in that area, a significant negative residual impact could occur at a community level for those households that remain.

There will be a significant residual amenity impact on visitors to Menlo Castle on the east bank of the river due to the presence of the River Corrib Bridge. The residual impacts on NUIG Sporting Campus remain as very significant in the absence of a new University Sports Masterplan. The proposed road development will be elevated across the Sports Campus, removing the two centrally located grass GAA pitches. In tandem with this the existing context of the existing sporting changing facilities setting and curtilage will be altered completely. An appropriate level of master planning and implementation of the following would reduce the residual impact to moderate:

1. The Sporting Campus at Dangan will require a new Sporting Campus Plan and strategy to re-accommodate the removed pitches and ancillary Sports Pavilion. This must be in line with the University's overall strategic sport's vision
2. The removal of the existing sports fields will require replacement by similar or more likely improved facilities which allow for the more intensive use of the remaining reduced Campus footprint
3. Utilities, roads and access and egress routes around the Campus will require complete re-planning to re-integrate with the proposed road development
4. The remaining sports pitches will require remodelling to accommodate a more intensive use of the existing Campus footprint
5. The landscape setting of the existing Campus will need to be developed to screen the visual effects of the proposed River Corrib Bridge from the surrounding pitches
6. Ancillary supporting facilities such as car parking and changing facilities will require remodelling

The residual impact on NUIG Sporting Campus post compensation cannot be assessed as the compensation to be agreed as part of the land acquisition is outside the scope of the EIA process.

18.7.1.3 Community Severance

The transfer of through and other traffic from more central areas of the city will allow space for improved and new crossing facilities for both pedestrians and cyclists in line with the GTS. Crossing facilities are also included for junctions between national, secondary and local roads and the proposed road development. These facilities will have the effect of reducing any residual impact arising from severance due to the road development itself.

18.7.1.4 Economic

The improved connectivity will help to stimulate economic development and the potential for development of the tourism sector in West County Galway. The proposed road development will have a significant positive residual impact in this regard. The availability of connections between the proposed road development and existing business parks in the west, and especially the east, of the city will also have a very significant, and in some cases, profoundly, positive economic impact due to improved access to these businesses. However, some businesses will be directly impacted by the route of the proposed road development and a few of these will be acquired or their current operations modified. These negative impacts will be addressed as part of the land acquisition process and financial compensation.

18.7.2 Irish Language

The proposed road development is expected to have a Moderate Positive residual impact on the status of Irish as a community language within the Galway Gaeltacht area.

18.7.3 Human Health

18.7.3.1 Health Protection

From a community perspective overall, there are potential benefits in terms of human health protection. These arise from overall reductions in noise levels in built-up areas and potential improvements in air quality in these areas. Unfortunately, there are individuals who have slight negative impacts because of their proximity to the proposed road development. The implementation of the mitigation measures will result in a residual slightly positive impact.

Similarly, from a psychological health point of view overall from community perspective the impacts of the proposed road development are assessed as being positive. Again, there are individuals who may be adversely affected and principal among these are likely to be those whose homes are to be compulsorily acquired. The residual impact will be positive.

18.7.3.2 Health Improvements

There is the potential for a very significant opportunity for health improvements associated with the proposed road development. These include the potential for economic development as well as tourism which in itself is associated with an improvement in health status. There is the potential for improvements in social health with a reduction in unemployment and particularly long-term unemployment. Such a potential if realised will bring with it benefits including reduced inequality in society. There is also potential for increased opportunity to exercise. There is the potential for reduced traffic accidents with a corresponding reduction in mortality and morbidity. Ease of access and egress has the potential to improve social interaction. It also will allow quicker and more reliable access for emergency services such as ambulances. The residual impact will be positive.

18.7.3.3 Improvement of Access to Services

There is potential for significant improvement in access to services. The benefits of this apply to both the residents of Galway City and beyond. Easier access to national road network will allow greater availability of national services such as major hospitals and others. This may be of particular benefit to those living to the west of the city including as far as Connemara. Decreased traffic in built-up areas of Galway City will allow easier access to the services such as retail, cinema, restaurants and other services. It may also encourage people outside of Galway, who are currently deterred from entering the city by traffic concerns to visit and access the services. The residual impact will be very positive.

18.7.4 Cumulative Impacts

Cumulative impacts are defined as the combination of many minor impacts creating one larger, more significant impact (NRA, 2009 and EPA 2017). Cumulative impacts consider existing stresses on the natural environment as well as developments that are underway and in planning.

Following a review of the committed projects and the planning files for Galway City and County Council, the cumulative impacts of the proposed road development on human beings, population and human health with the following have been assessed:

- The planning registers for Galway City and County Council
- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- M6 Motorway Service Area (Rathmorrissy Interchange) (pre-planning)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS), which includes the following:
    - Investigation of prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway
- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021
- Bearna Local Area Plan 2007–2017
- Gaeltacht Local Area Plan 2008–2018
- Údarás na Gaeltachta's Strategic Plan 2014–2017
- Ardaun Local Area Plan 2018–2024

No projects or plans other than those listed in this chapter were identified as having potential cumulative impacts.

18.7.4.1 Socio-Economics

The proposed road development will improve accessibility both within and to/from Galway City and connectivity between areas outside of the city including Connemara, the East and North West. As a result, there are significant potential positive impacts which will benefit economic and regional development, including tourism. The proposed road development will have a positive cumulative socio-economic impact with the proposed roads projects listed above and with the proposed the Galway Harbour Project.

The proposed road development could also stimulate new physical commercial or tourism development. These developments would be subject to planning assessment given the objectives set out in the Galway City and Galway County Development Plans to consolidate development and to provide for balanced sustainable development. They will also be subject to Appropriate Assessment to avoid any adverse impacts on sensitive landscapes and natural habitats. These considerations apply also to the largely rural area surrounding the city, noting that the proposed road development will be used for a proportion of commuting journeys as well as for regional journeys. The transfer of some of these journeys to the proposed road development away from the existing N6 is a significant positive impact, but any cumulative impacts on settlement patterns will be monitored and addressed in future development and local area plans.

The proposed road development will provide an opportunity to fully implement the GTS and to provide for improved public transport and facilities for pedestrians and cyclists. For example, the reduced volume of traffic on the existing N6 will present an opportunity to greatly improve the continuity of cycle lanes, including at junctions, and to add more pedestrian crossings, while minimising impacts on traffic flow. Once implemented, this will have a very significant impact on safety and the journey amenity of pedestrians and cyclists, and on general environmental quality if this contributes to a modal transfer from vehicles. In summary the cumulative impacts of the projects and plans listed above in association with the proposed road development are positive.

18.7.4.2 Irish Language

Having considered the proposed road development in tandem with other relevant plans or projects identified above, it is considered that no significant negative cumulative impact upon the status of Irish as a community language will occur.

18.7.4.3 Human Health

It is not considered that there will be any negative cumulative effects on human health. The distances between the projects noted above and the proposed road development results in no cumulative noise or air quality impacts. There is potential that reduced journey times and fewer unforeseen delays could have a potential benefit on psychological health. Any projects which make roads safer and reduce the probability of road accidents and fatalities can only be seen in positive terms from a human health perspective. The cumulative health benefits of the proposed road development with the GTS are further assessed below.

Quantification of cumulative health benefits with the GTS

The cumulative health benefits of the proposed road development with the GTS were assessed by using the Western Regional Model to quantitatively measure some of the health, accessibility and social inclusion[30] impacts once the proposed road development and the GTS were fully implemented.

[30] It should be noted that this analysis represents an assessment of those elements of Health, Accessibility and Social inclusion which can be measures using model outputs from the WRM. As such, these outputs are not representative of all the benefits/disbenefits which result from the implementation of the GTS under these categories.

<u>Physical Activity Analysis</u>

The assessment indicates that the total number of people cycling, over a 24-hour period in Galway City, will increase by approximately 21% cyclists as a result of the implementation of the GTS and associated cycling infrastructure improvements. This increase in cyclists will result in a reduced risk of premature deaths for those who are new to cycling and currently exercise infrequently. By comparison, results from the assessment indicate that pedestrian trips (trips which use walking only to get from origin to destination) in Galway City are expected to decrease marginally (less than 1% reduction) across the full 24-hour period. The reduction in pedestrian activity in Galway City is mostly as a result of people transferring to cycling or using the improved public transport services implemented as part of the Galway Transport Strategy.

<u>Accessibility Analysis</u>

The changes in accessibility for key locations were determined on a zone by zone basis. This was undertaken using a visual representation of the changes in journey times between the 'Do-Nothing' and 'Do-Something' Scenarios for cycling, public transport and private car. **Plates 18.4** to **18.6** below represent the changes in journey time (on average) required to access NUIG, GMIT, Galway University Hospital, Galway Clinic, Bons Secours and the industrial estates at Ballybrit and Parkmore when the GTS has been implemented for car, cycling and public transport. **Plate 18.4** illustrates that, in general, most zones experience a decrease in car journey times. There are however, a small number of zones, mostly in the city centre, which are expected to experience an increase in car journey times to access key sites. This is as a result of the public transport priority measures, such as private vehicle restrictions on Salmon Weir Bridge, which make accessing these areas by car more difficult.

Plate 18.4: Changes in Car Accessibility

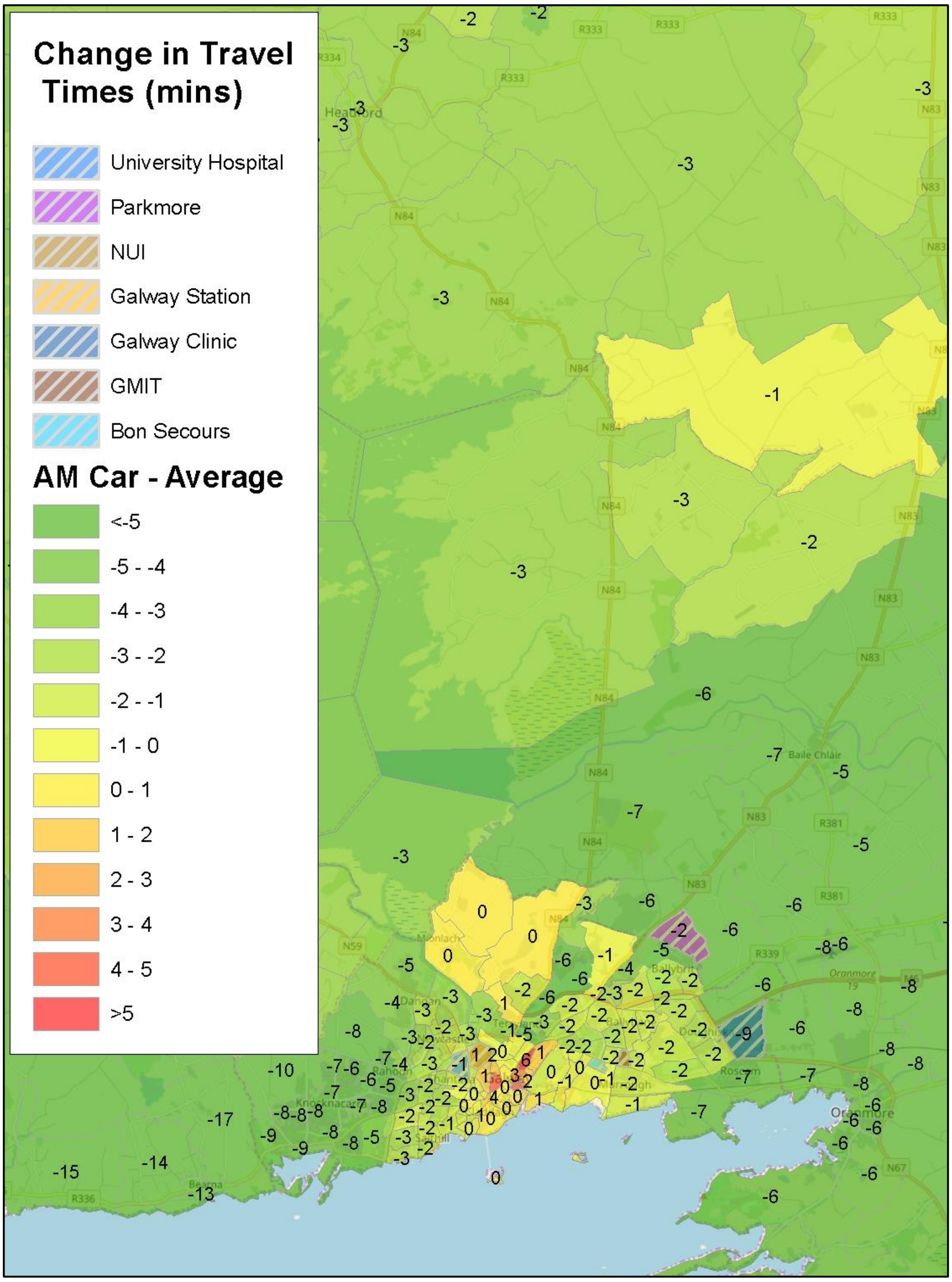


Plate 18.5 illustrates that all zones will experience improved cycling journey times.

Plate 18.5: Changes in Cycling Accessibility

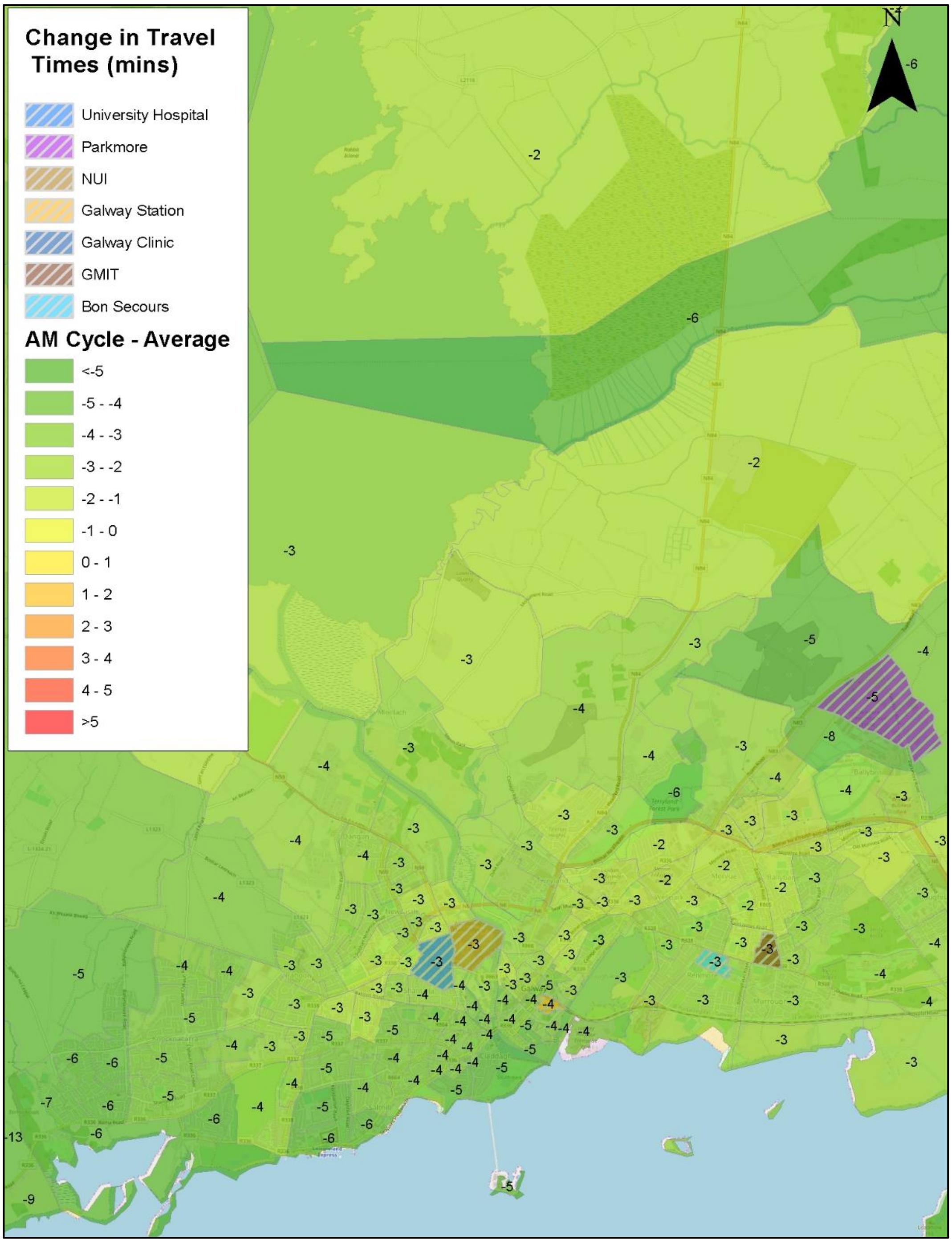
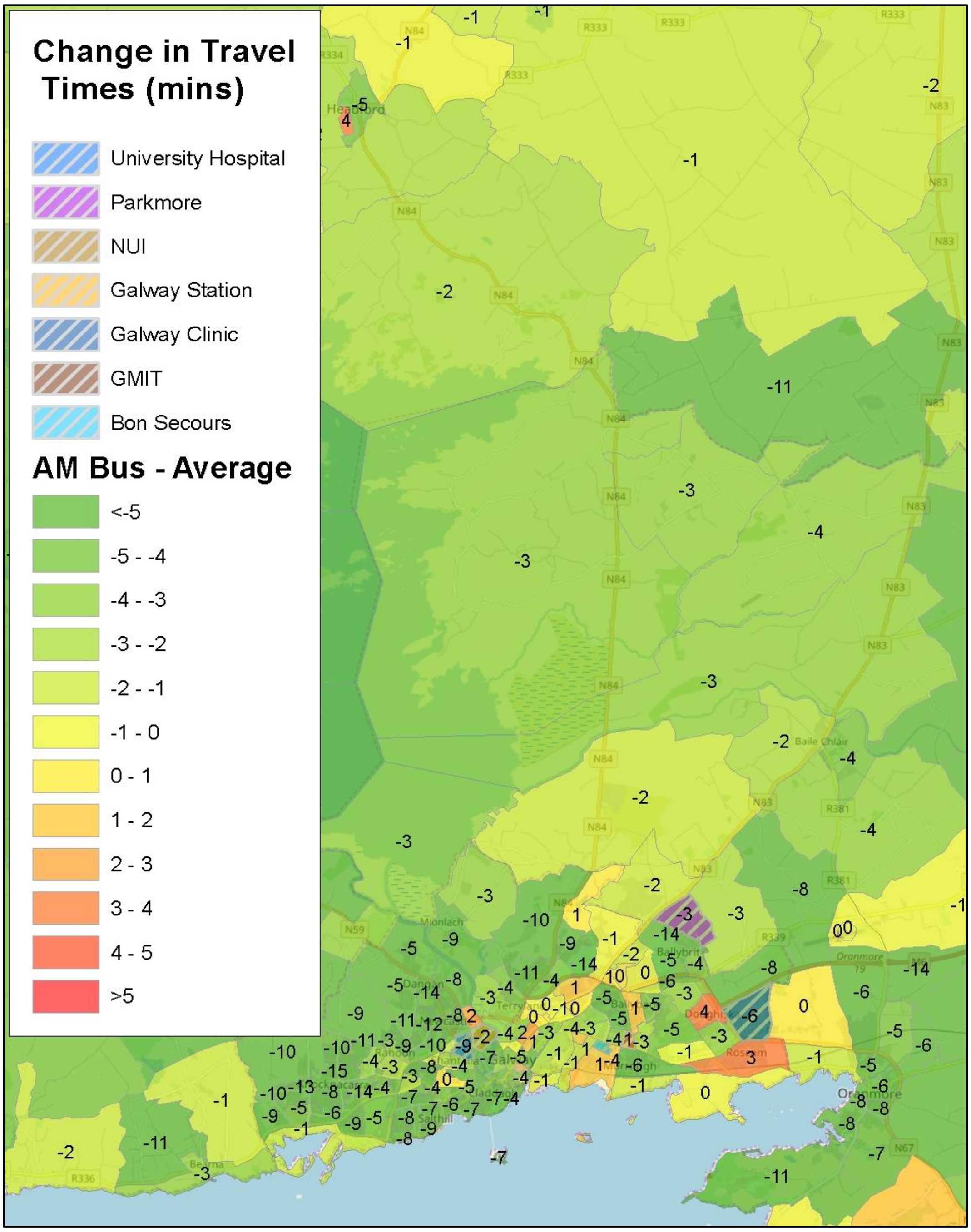


Plate 18.6 illustrates that, in general, most zones experience a decrease in public transport journey times. There are however, a small number of zones which are expected to experience an increase in public transport journey times as they will not be served as directly by public transport once the changes in bus routes proposed as part of the GTS are implemented.

Plate 18.6: Changes in Public Transport Accessibility



<u>Social Inclusion Analysis</u>

Outputs from the traffic model have also been used to assess the impacts of the Galway Transport Strategy in terms of Social Inclusion. For this assessment, the outputs from the economic module (produced using the software Tuba) were used to visually identify which locations would benefit or suffer disbenefits as a result of the GTS. The benefits in this instance are measures in terms of journey time saving. These benefits/disbenefits were then compared against the deprivation index for the same locations to illustrate graphically how the benefits of the proposed road development are distributed among affluent and less affluent areas. **Plates 18.7** and **18.8** below illustrate the car trips and public transport trips benefits experienced by each model zone following the implementation of the GTS measures and compare these to the deprivation index for that zone.

Plate 18.7: Social Inclusion - Car

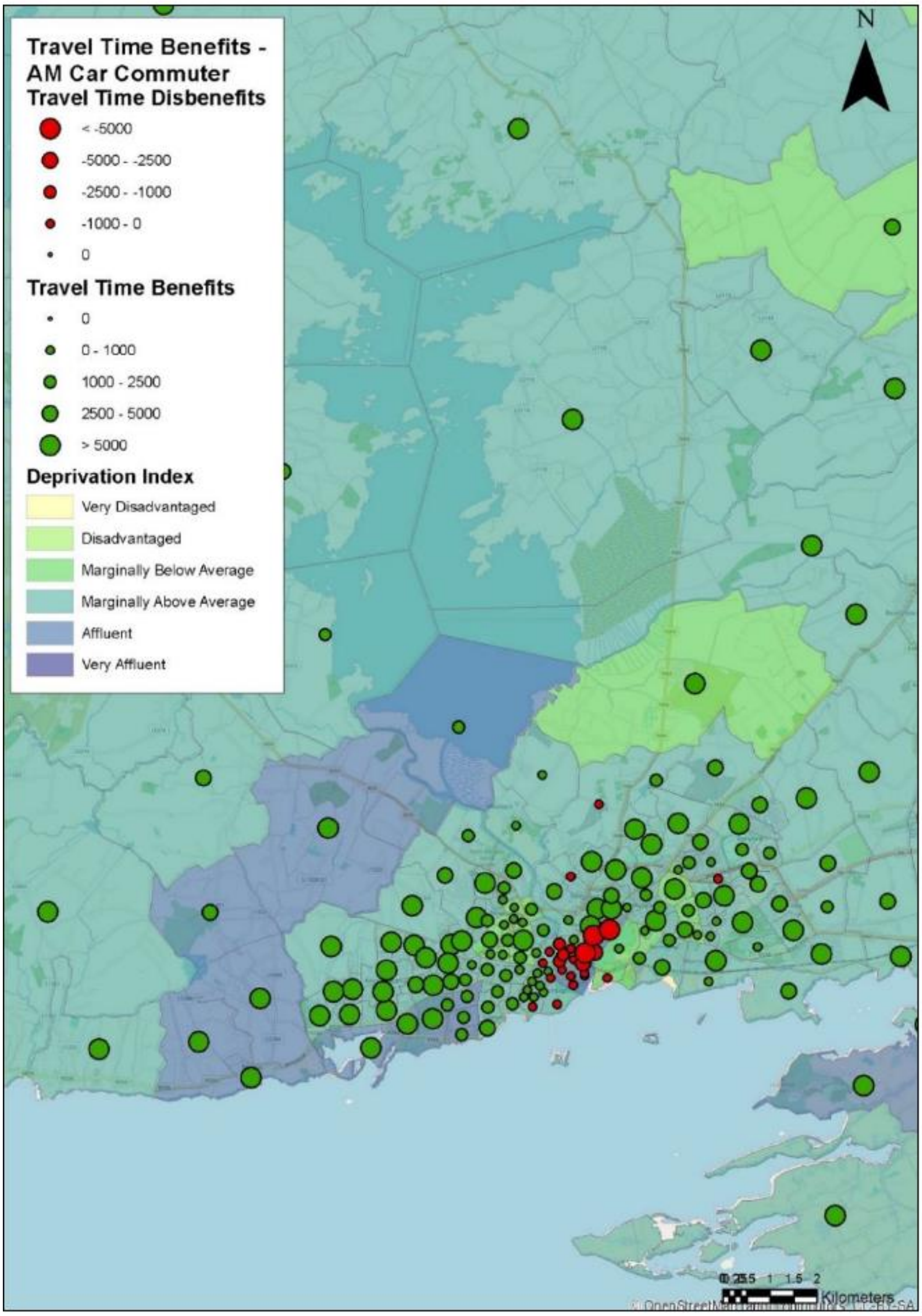
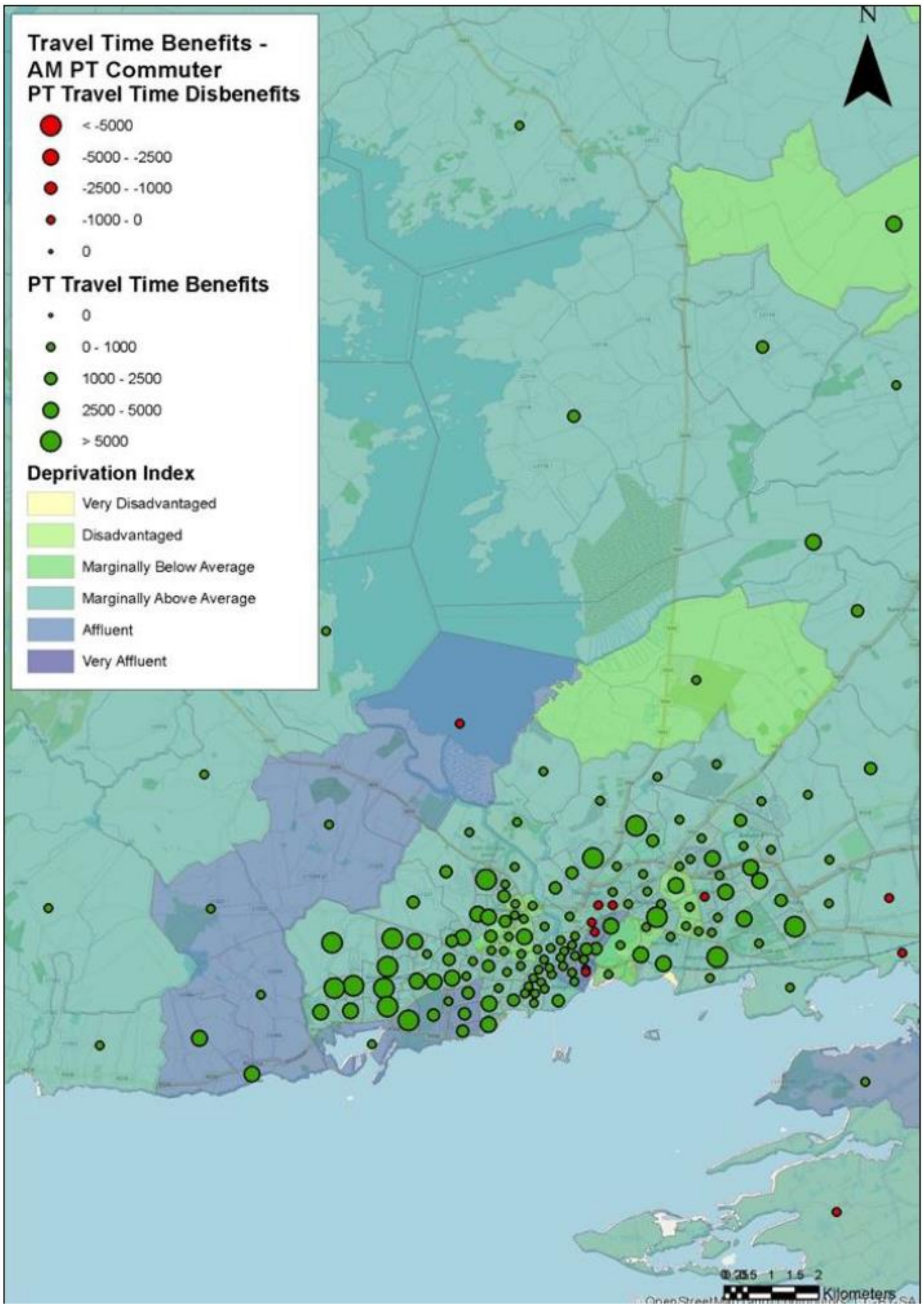


Plate 18.8: Social Inclusion – Public Transport



These maps show that most zones will experience an improvement in journey times for all trips from those zones. Some city centre zones however, will experience increase in journey times by car following the implementation of the GTS measures. This is a result of public transport priority measures and public realm enhancements in the city centre which will increase travel time for some car trips into and around the city centre. With respect to **Plate 18.8**, a small number of zones are seen to experience marginal disbenefits as a result of bus route changes which give these zones less direct access to the public transport network. Comparison of these benefits with the deprivation index show that, in general, the benefits of the proposed road development are distributed evenly between disadvantaged and more affluent areas.

18.8 Summary

18.8.1 Socio-Economics

A socio-economic assessment of the proposed road development was carried out and focused on aspects such as journey patterns, amenity and community severance, business, tourism, employment, ecosystem services and use of the Irish language. Data for the assessment was collected primarily through a review of relevant documents and information gathered through the extensive public consultation. This data was supported by site and home visits and local discussions with residents, businesses, schools and representatives of other community facilities. Furthermore, a Language Impact Assessment (LIA) for the proposed road development was undertaken.

A summary of socio-economic impacts, mitigation measures and residual impacts is provided in **Tables 18.14** and **18.15** below. Overall, the proposed road development will provide a much needed bypass of Galway City for regional traffic heading to destinations to and from the west of Galway, such as Connemara, to the rest of Ireland. As such, it will provide a very significant reduction in journey times. It will improve the accessibility of Galway City to its main markets by facilitating the crossing of the River Corrib without the need to go through the central suburbs of the city and connect to the national road network. This will increase the connectivity of key strategic services within Galway, such as NUIG and Galway University Hospital, to the national road network. It will also improve the accessibility of Gaeltacht areas to the remainder of the county and country, thereby facilitating reductions in the economic and social disadvantages of the Gaeltacht areas. It will also reduce the journey times of traffic heading to various parts of the city from destinations in its rural hinterland, including areas such as that north of Bearna. This will open up new opportunities for residents to access more distant parts of Galway City, for instance for employment.

The transfer of this traffic from more central locations will improve journey amenity for all users of the existing road infrastructure. In particular, it will open up road space for the provision of improved and more continuous pedestrian and cycle facilities and provide opportunities for new public transport in line with the objectives of the GTS. The transfer of traffic will contribute to improve amenity and general well-being of communities living within or beside busy urban roads. Community severance will be reduced through a moderation or reversal of the trend towards increased road traffic and through the opportunity to provide new crossing facilities.

The proposed road development has been designed to avoid as many residential properties as possible, but given the distribution of development and the presence of linear development of the city with housing along most roads radiating out of the city, its construction will unfortunately and unavoidably result in a number of property demolitions or acquisitions with some concentrations in particular areas. At some locations, a high proportion of properties will be acquired as part of the proposed road development. As well as the direct negative impact on the householders themselves, this will present a varying negative impact on remaining residents and at a community level depending on the strength of community interaction that has evolved at each location and the sustainability of community facilities such as schools. There will, also be some loss of amenity for a small number of residents living in the vicinity of the proposed road development, particularly in the east of the study area and where major junctions are located. In several locations, and particularly in Na Foraí Maola and the vicinity of the N59 Moycullen Road, the N84 Headford Road and in Castlegar, there will be a significant impact on local communities due to the need to acquire or demolish a high proportion of existing properties during construction in these areas. The proposed road development will have an impact on approximately 6.750ha of lands zoned residential by Galway City and County Council.

The eastern section of the proposed road development impacts several businesses. It will cross Lackagh Quarry which is currently inactive. Whilst the quarry is currently inactive, parts of the upper benches will be sterilised as a result of the proposed road development. At the N84 Headford Road, a very significant impact is anticipated during the construction phase on a company located here which bottles water and distributes fruit and vegetables. The impact arises from the effect of landtake on one warehouse and an impact on the company’s raw material supply. At the N83 Tuam Road there will be impacts on commercial properties, with the acquisition of a builders’ providers store and landtake from other businesses. A car dealership and An Post sorting centre could be affected by the need for traffic management during construction, but will have safe access in the operational phase of the road. There will also be an acquisition of a builders’ providers store at Ballybrit and some landtake from a car dealership at Briarhill. All of these impacts will be addressed as part of the land acquisition process and through financial compensation, but again these businesses represent the livelihoods of many individuals and so impacts will be moderate to significant. The proposed road development will have an impact on approximately 8.100ha of lands zoned commercial or industrial by Galway City Council.

The proposed road development will have a very significant negative residual impact on the NUIG Sporting Campus at Dangan, although this can be reduced to moderate with appropriate master planning as described in **Section 18.7.1.2**. Two pitches, one of which has planning permission for conversion to a 3G pitch with flood lighting, and part of a sports pavilion will be lost. A new 3G pitch and training pitch with flood lighting will be provided as a replacement. The sports facility will be permanently impacted by the presence of an overhead viaduct carrying the road towards the crossing of the River Corrib. There will be no physical severance, but the crossing will impact on the amenity of users of the sports facility and amenity use of the riverside.

The proposed location of the Galway Racecourse Tunnel means that there will be no direct amenity impacts on the racecourse business or racing events during operation. New permanent access will be available to the N83 Tuam Road via the Parkmore Link Road and much improved access will be possible from the existing N6 such that the net impacts will be positive.

Furthermore, the proposed road development will have a significant positive impact on the Galway economy by reducing traffic congestion which currently constrains economic growth and competitiveness. The improved connection provided with destinations to the west of Galway City will have a positive impact on the potential for economic development and continued growth in tourism numbers. The transfer of a proportion of traffic from existing urban roads could also help to draw more visitors into the city with consequent benefits for tourism-related businesses and the economy. Similarly, the improved connectivity with Connemara and locations to the west will help to attract tourism investment and related economic development.

Ecosystem services provide many varied benefits that humans freely gain from the natural environment. A properly functioning ecosystem has the capacity to regulate and support the natural environment that contributes to human well-being. The potential impacts on ecosystem services were considered through the assessment of the environmental factors (pathways) through which ecosystem services could be affected such as water, soils, air, noise and general amenity and relied on the biodiversity assessment in terms of potential impacts to biodiversity and indirectly to ecosystem services. There are no impacts identified in those assessments which would result in a significant residual impact on ecosystem services during the construction of the proposed road development.

18.8.2 Irish Language

In relation to the Irish language, there is a low-level of daily Irish usage among the population of the area directly affected by the proposed road development, and where it exists, the use of Irish is particularly concentrated in an education context. While population is increasing, the use of Irish as a community language is not growing in parallel. The proposed road development will not have any significant impact on the use of Irish into the future. However, it is noted that an improved road network may facilitate further migration and economic growth into the wider Galway Gaeltacht and as the west of County Galway have higher levels of unemployment and deprivation than the areas around Galway City, the proposed road development, by improving access to employment opportunities to the east of the city, will facilitate Irish speakers to commute more easily from their own communities and lessen the need to re-locate for economic reasons. Equally, as noted above, the proposed road development will make Gaeltacht areas to the west of Galway City more attractive for residential and commercial development. In this context, it will be the responsibility of Galway County Council, Galway City Council and Údarás na Gaeltachta among others to ensure that the use of the Irish language is promoted and encouraged among new residents.

18.8.3 Human Health

The potential health impacts due to the proposed road development were also assessed. The health assessment in the context of EIA focuses the attention of the assessment on likely significant effects, i.e. on effects that are deemed likely to occur and, if they were to occur, would be expected to be significant (as per the requirements of the EIA Directive).

The health assessment focused on three main areas: *health protection, health improvement and improving services*. A review of current and emerging guidance on assessing health in EIA was undertaken in addition to a literature review on the impacts of health from road developments.

18.8.3.1 Health Protection

The data collected in relation to the protection of human health focused on the results of technical assessments (such as noise, air, soil and water) dealt with elsewhere in **Chapter 9, Soils and Geology**, **Chapter 10, Hydrogeology**, **Chapter 11, Hydrology**, **Chapter 16, Air Quality and Climate** and **Chapter 17, for Noise and Vibration** and their mitigation to establish any potential hazard directly attributed to what is proposed.

These technical assessments provided elsewhere in the EIA Report use standards[31] (such as air quality standards) in order to identify whether significant impacts will arise or not. It is important to point out that health standards do not only exist to protect robust groups within the population, but are primarily intended to protect the vulnerable. The standards are set at levels for which there will be no significant health effects, but do not exclude each and every effect, i.e. slight or moderate health effects are possible even below the levels at which health based standards would apply.

Construction noise is expected to have some negative effects; however it will be short term and limited by work practices and restricted working hours. The results of the noise modelling carried out for the operational phase shows that there may be potential noise impacts on residential properties adjacent to the proposed road development, but that the implementation of low noise road surfacing and noise barriers will mitigate these potential impacts. The noise assessment also shows that there will be a benefit for a significant number of people within the city due to a proportion of current traffic being transferred from their current routes. On the basis of WHO night-time noise guidelines, there will be beneficial effects for the community living along existing roads where traffic will be reduced. Those few residences that may exceed the 55dB level do so by only small margins and are not considered to be enough to have significant health impacts.

Air quality has been considered in both the construction and operational phases. Given the proposed mitigation measures with regards to control of dust and other air emissions during the construction phase and the relative limited period of time duration, air quality impacts are not expected to have an adverse effect on human health during the construction phase. Detailed modelling based on worst case traffic scenarios identify that Air Quality Standards will not be breached thereby protecting the vulnerable such as asthmatics, the elderly, the very young or the sick in general.

Adverse effects on soils, water quality or quantity are not predicted either during the construction or the operational phases.

Whilst some annoyance during the construction phase is to be expected, this will be of limited duration and is not usually considered to be a health effect. There are potential psychological benefits in terms of reduced journey times, unforeseen delays etc. as well as movement of traffic away from currently congested and more populated areas. The transfer of a proportion of traffic to inherently safer roads, together with the prospect of reduced traffic accidents and fatalities is also an

[31] The term standards in this instance covers guidelines for example noise guidelines as such standard are not currently available.

important potential benefit. This does not take away from the adverse effects on individuals whose homes are to be compulsorily acquired. As noted above, the proposed road development has been designed to avoid as many properties as possible, but there remains a significant number of property acquisitions and, although subject to financial compensation[32], it is important to recognise that these individuals may experience stress and anxiety as a result of this process.

18.8.3.2 Health Improvement and Improvement of Access to Services

The data used to assess opportunities for health improvements and access to services included information gathering during the extensive public consultations including a meeting with University Hospital Galway and data extracted from the traffic model to identify accessibility to services.

There is potential for socio-economic gain including economic growth and development of tourism as a result of the proposed road development and it is well recognised that improved socio-economic status will have a positive impact on health outcomes. There is potential for increased employment and reduced unemployment particularly long-term unemployment. If this is achieved, there will also be benefits in terms of social health including decreased social inequality.

Other opportunities for health improvements associated with the proposed road development include a potential decrease in road traffic accidents, the potential for creating opportunities for improved public transport and an improved environment for cycling and walking within the city centre roads previously occupied by heavy traffic.

The cycling measures of the GTS, which can be fully implemented once the proposed road development is operational, will lead to a considerable increase in cyclists within Galway City. This increase in cycling will lead to an overall increase in the health benefits for those who currently do not cycle. The substantial improvements in cycling and public transport infrastructure due to the GTS will result in a marginal decrease in pedestrian activity (less than 1%) as some existing pedestrians are expected to switch from walking to public transport and cycling.

A quantification of some of the accessibility and social inclusion benefits of the proposed road development and all the GTS measures demonstrate that there will be improvements in accessibility and social inclusion for almost all parts of Galway City. In general, the measures will lead to reduced journey times by all modes and will improve accessibility to key locations within the city and more importantly none of the more disadvantaged areas experience any disbenefits.

There is potential for more efficient access to emergency services including ambulances as a result of the proposed road development. There is also the potential for increased opportunities to exercise with the associated health benefits.

[32] Compensatory measures for the loss of land, buildings and other injurious affection will form part of the land acquisition process and will be agreed at a later date with a valuer. Compensation does not form part of the EIA process and is therefore not considered further.

There are significant opportunities for improved access to services. This will include those living within Galway City and its environs and those in the west of Galway. For those within Galway City and its environs, reduced traffic along city streets will facilitate access to services including health centres. For those living outside of Galway City there is the potential for improved access to the national road network and thereby access to other services including national hospitals. For those who require to cross the city centre to access services the proposed road development offers particular benefits. While this would be of benefit to all, it will be of particular benefit those living to the west of the River Corrib.

Overall, therefore the impacts of the proposed road development on human health are primarily positive. From a community perspective, there are clear benefits in terms of health protection, opportunities for health improvements and access to services. There are however a limited number of individuals, primarily those living close to the proposed road development for whom there may be slight adverse outcomes in terms of noise and air quality. These will be minimised through the use of mitigation measures.

18.8.3.3 Summary

In summary from a human health perspective, the proposed road development will have no significant adverse effects on human health and the proposed road development and the full implementation of the GTS will have positive impacts on human health.

Table 18.14: Summary of Construction Impacts - Socio-economic

Nature of Impact	Location / Sub-Group	Current situation	Construction Impact	Significance	Duration	Extent	Proposed Mitigation	Residual Impact
Journey characteristics	Major roads: N59 Moycullen Road, N84 Headford Road, N83 Tuam Road, R339 Monivea Road	n/a	Temporary night time closures and diversions of these roads which carry significant traffic including at night	Slight to Moderate negative	Short term	Medium	Traffic management to minimise delays	Slight negative
Journey characteristics	Where minor roads meet construction works	n/a	Slight diversions or Stop / go arrangements	Imperceptible to slight negative	Short term	Medium	Traffic management to minimise delays	Imperceptible
Journey characteristics	Rahoon Road & Letteragh Road	n/a	Temporary night time closures	Slight negative	Short term	Few	Avoid extended night time closures	Imperceptible to Slight negative
General amenity	Rosán Glas estate	n/a	Construction of link road beside estate and new access connection	Slight to moderate negative	Short term	Medium	Minimise access disruption to estate. Temporary visual screening	Slight negative
General amenity	Gort na Bró estate	n/a	Realignment of Gort na Bró Road which provides access to estate	Slight negative	Short term	Medium	Minimise access disruption to estate and gaelscoil.	Imperceptible to Slight negative
General amenity	Bushypark Church	Local community facilities	Construction traffic movements impacting on use of church and adjacent cemetery	Slight negative	Short term	Medium	Traffic management and temporary visual screening from construction works	Imperceptible to slight negative
General amenity	NUIG Sporting Campus	Sports and amenity use	Noise and visual impacts, loss of use of playing pitches and modification of the sports pavilion, as the central part of the	Very significant negative	Medium term	Many	Construction traffic and works for the River Corrib Bridge will be managed to minimise	Significant negative

Nature of Impact	Location / Sub-Group	Current situation	Construction Impact	Significance	Duration	Extent	Proposed Mitigation	Residual Impact
			sporting campus will become a construction site				interference with sporting activities and spectators. Provision of a floodlit 3G GAA pitch, a floodlit 3G training area and associated site infrastructure such as drainage of these pitches and ball-stop netting and modification of the sports pavilion	
General amenity	River Corrib crossing	Amenity use	Noise and visual impacts	Mix of positive and significant negative for different receptors	Medium term	Medium	Minimise duration of any restrictions on access below the bridge works and advice of alternative routes	Moderate negative – positive on balance.
General amenity	An Seanbóthar	Amenity use	Construction vehicle movement	Moderate negative	Short term	Few	Avoid severance and minimise duration of use by construction traffic	Slight to Moderate negative
General amenity	Cappanabornia (beside N83 Tuam Road)	Residential area of 6 houses with direct access to the N83 Tuam Road	Construction of new access road to dwelling and removal of direct access to the N83 Tuam Road. Visual impacts due to the construction of the proposed N83 Tuam Road Junction	Significant negative	Medium term	Few	Minimise disruption to access. Visual and noise barriers. Refer also to **Chapter 12, Landscape and Visual** and	Moderate negative (access)

Nature of Impact	Location / Sub-Group	Current situation	Construction Impact	Significance	Duration	Extent	Proposed Mitigation	Residual Impact
							Chapter 17, Noise and Vibration	
General amenity – property demolition and acquisition (private level)	Route of proposed road development	Rural area with a high number of one-off dwellings and semi-urban areas	Demolitions of 44 and acquisition of 10 dwellings	Significant to Profound negative (owners & occupants)	Permanent	Many	In the event of an approval of the Protected Road Scheme and Motorway Scheme and approval under Section 51 of the Roads Act 1993 (as amended), by An Bord Pleanála and subject to the availability of funding, Notice to Treat will be served firstly on owners, lessees and occupiers of the dwelling houses and commercial properties to be acquired, within six months of the scheme becoming operative, unless an application has been made for Judicial Review, in which case the	Subject to financial compensation as part of the compulsory purchase process

Nature of Impact	Location / Sub-Group	Current situation	Construction Impact	Significance	Duration	Extent	Proposed Mitigation	Residual Impact
							Notice to Treat33 will be served in accordance with the provisions of Section 217 (6A) of the Planning and Development Act 2000 as inserted by the Compulsory Purchase Orders (Extension of Time Limits) Act 2010. Compensation will be agreed or determined by the property arbitrator as soon as possible after service of Notice to Treat. After compensation has been agreed or determined and satisfactory title has been produced, part payment can be made while the claimant remains for an agreed period in the property to be acquired. This will	

[33] This notice requests landowners to submit their claim for compensation for lands being taken under the Protected Road Scheme or Motorway Scheme. This is the initial step in the acquisition of property and lands.

Nature of Impact	Location / Sub-Group	Current situation	Construction Impact	Significance	Duration	Extent	Proposed Mitigation	Residual Impact
							facilitate the claimant in removing uncertainty and will facilitate arrangements being made, as early as possible, to secure a replacement property. Refer Chapter 15, (community level) Material Assets	
General Amenity - demolitions (community level)	Na Foraí Maola / Troscaigh	Semi-dispersed community	Acquisition or demolition of 7 properties (+1 site with planning for a dwelling) with impact on local community	Significant negative (wider community)	Long term	Medium	Public Communications Strategy as set out in the CEMP which will include procedures to inform members of the community who will be directly affected by the construction phase on schedules for any activity of a particularly disruptive nature which is likely to impinge on their property.	Significant to Moderate negative

Nature of Impact	Location / Sub-Group	Current situation	Construction Impact	Significance	Duration	Extent	Proposed Mitigation	Residual Impact
General Amenity - demolitions (community level)	Ard an Locha	Small residential estate	Acquisition or demolition of 3 properties (+2 site with planning for a dwelling) with impact on wider community	Very significant negative (wider community)	Long term	Few	Consult and liaise with residents in local community	Significant negative
General amenity – demolitions (community level)	Aughnacurra, Bushypark	Small residential estate	Acquisition or demolition of 6 properties representing a high proportion of the wider community	Very significant negative (wider community)	Long term	Medium	Consult and liaise with residents in local community	Significant negative
General amenity – demolitions (community level)	N84 Headford Road,	Linear residential development, mainly on one side of road	Demolition of 14 properties representing a high proportion of the wider community	Very significant negative (wider community)	Long term	Medium	Consult and liaise with residents in local community	Significant to negative
General amenity – demolitions (community level)	Castlegar	Residential area including school and other community facilities	Acquisition or demolition of 7 properties representing a high proportion of the wider community	Very significant negative (wider community)	Long term	Medium	Consult and liaise with residents in local community	Significant negative
Severance	Locations north and south of the proposed road development in west of study area, School Road, N59 Moycullen Road, N84 Headford Road & N83 Tuam Road	No north-south severance, but high traffic volumes on some roads	Physical and social severance during construction phase	Moderate to slight negative	Short term	Few-medium	Allow for vehicle, pedestrian / cycle crossing	Slight negative
Severance	N84 Headford Road	High volume of existing traffic	Road to be used by construction traffic	Slight negative	Short term	High	Minimise vehicle movements during peak traffic hours	Imperceptible to Slight negative

Nature of Impact	Location / Sub-Group	Current situation	Construction Impact	Significance	Duration	Extent	Proposed Mitigation	Residual Impact
Severance	NUIG Sporting Campus	n/a	Construction of proposed bridge over River Corrib	Significant negative	Short term	Medium	Maintain continuous, if restricted access	Slight negative (physical severance)
General economic	NUIG Sporting Campus	Rental of sports pitches and facilities and some related use of accommodation.	Some loss of this income due to unavailability of pitches.	Slight negative	Short term	Medium	-	Slight negative
Economic	Business on the N84 Headford Road	Business which bottles water and distributes fruit and vegetables	Landtake on one warehouse and an impact on the company's raw material supply and potential business impact	Very significant negative	Long term	1 business	Subject to financial compensation as part of the compulsory purchase process	Subject to financial compensation as part of the compulsory purchase process
Economic	Business on the N83 Tuam Road	Hardware / builders providers	Full acquisition of business	Very significant negative	Permanent	1 business	Subject to financial compensation as part of the compulsory purchase process	Subject to financial compensation as part of the compulsory purchase process
Economic	Business on the N83 Tuam Road	Car dealership	Dust and noise impacts during construction. Partial landtake and possible effect on visibility of business during construction	Moderate negative	Short term	1 business	Noise and dust control measure during construction. Signage to direct accessibility	Slight-moderate negative
Economic	Business on the N83 Tuam Road	Postal business	Partial landtake. Traffic management and access	Slight to moderate negative	Short term	1 business	Signage to direct accessibility	Slight negative

Nature of Impact	**Location / Sub-Group**	**Current situation**	**Construction Impact**	**Significance**	**Duration**	**Extent**	**Proposed Mitigation**	**Residual Impact**
Economic	Businesses in Parkmore Business Park	Business park	Potential impact from noise, dust or vibration during tunnel works	Slight to Significant negative	Short term	Medium (approx. 6 businesses)	Noise and dust control measure during construction. Tunnel works will be undertaken in compliance with the CEMP in **Appendix A.7.5**	Imperceptible to slight negative
Economic	Galway Racecourse	Galway Racing Festival and tourism venue	Partial landtake, construction of a cut-and-cover tunnel, removal of stables, temporary loss of some car parking and some other facilities	Significant negative	Short term	Principally one business	Works phased to minimise racing events. Replacement of stables and well	Slight negative during construction.
General amenity (trainers & spectators)	Galway Racecourse	Major community and tourism facility	Cut-and-cover tunnel construction. Temporary loss of car parking	Potentially significant negative	Medium term	Many	Construction works phased to minimise impacts on racing events	Slight negative during construction
Economic	Car dealership Briarhill Business Park	Business visible from existing N6 and Ballybrit Crescent	Dust and noise impacts during construction. Partial landtake requiring a reconfiguration of services on the residual lands and possible effect on visibility of business during construction	Very significant negative	Some short term, mostly long term	1 business	Noise and dust control measure during construction. Signage to direct accessibility	Significant negative
Economic	Tourism	Attraction of city as a tourist destination significantly affected by traffic congestion	Construction work located away from city centre and existing through routes. Possible impact on traffic movements on N59	Slight negative	Short term	Many businesses dependent on tourism	Minimise road closures or diversions	Imperceptible (during construction)

Nature of Impact	**Location / Sub-Group**	**Current situation**	**Construction Impact**	**Significance**	**Duration**	**Extent**	**Proposed Mitigation**	**Residual Impact**
			Moycullen Road, N84 Headford Road & N83 Tuam Road					

Table 18.15: Summary of Operational Impacts - Socio-economic

JOURNEY CHARACTERISTICS								
Nature of Impact	**Location / Sub-Group**	**Current situation**	**Operational Impact**	**Significance**	**Duration**	**Extent**	**Proposed Mitigation**	**Residual Impact**
Journey time and connectivity	Regional	Long and congested connection between M6 east of Galway and N83 Tuam Road, N59 Moycullen Road and R336 west	Much reduced travel time and avoidance of regular congestion	Profound positive	Long term	Very many	-	Profound positive
Journey time	Mainly local Galway City	Prolonged journey time on existing N6 through Galway City and regular congestion.	Reduced incidence or scale of congestion due to transference of much traffic	Very significant positive	Long term	Very many	-	Very significant positive
Journey time	Bearna and western Galway suburbs	Regular delays in Bearna Village particularly during morning and peak hours including the holiday season	Transference of high proportion of traffic from Bearna Village and reduced incidence of congestion	Significant positive	Long term	Many	-	Significant positive
Connectivity	Small communities and residential development north of Bearna Village	Access to the city and east only via minor roads with light traffic	Direct access to proposed road development via Bearna East Roundabout	Significant positive	Long term	Medium	-	Significant positive
Connectivity	Between proposed road development and Boleybeg / Western Distributor Road	Access to the city and east via minor roads with light traffic or Western Distributor Road	More direct access to the proposed road development via Cappagh Road Junction	Moderate positive	Long term	Many	-	Moderate positive
Connectivity	Ballymoneen and Western suburbs	Dependence on Western Distributor Road for access	Direct access to the proposed road development via Ballymoneen Junction	Moderate positive	Long term	Many	-	Moderate positive

JOURNEY CHARACTERISTICS								
Nature of Impact	**Location / Sub-Group**	**Current situation**	**Operational Impact**	**Significance**	**Duration**	**Extent**	**Proposed Mitigation**	**Residual Impact**
Connectivity	N59 Moycullen Road	Poor access between N59 Moycullen Road north of Galway and Rahoon or the busy existing N6 to the south	Alternative access via links road north and south of N59 Letteragh Junction to the proposed road development. Relief from congestion at Browne Junction.	Very significant positive	Long term	Very many	-	Very significant positive
Connectivity	N84 Headford Road	Access between N84 Headford Road and Kirwan Roundabout	Alternative access from the N84 to the proposed road development	Significant positive	Long term	Many	-	Significant positive
Connectivity	N83 Tuam Road	Access between N83 Tuam Road and Connemara or local business parks	Access to proposed road development from the N83 Tuam Road Junction	Very significant positive	Long term	Very many	-	Very significant positive
Connectivity	Parkmore Link Road	Limited access between the Parkmore Business Park, the N83 Tuam Road and the existing N6	Access to Parkmore, City East and Ballybrit Industrial Estates	Profound positive	Long term	Very many		Profound positive
Journey time	Ballybrit Crescent and Lynch Junctions	Frequent congestion and delay at these junctions and with existing N6 traffic	Transference of traffic to proposed road development and Parkmore Link Road providing for reduced traffic delays and congestion	Very significant positive	Long term	Very many	-	Very significant positive

AMENITY – Journey amenity								
Nature of Impact	**Location / Sub-Group**	**Current situation**	**Operational Impact**	**Significance**	**Duration**	**Scale**	**Proposed Mitigation**	**Residual Impact**
Journey amenity	R336 between centre of Bearna Village and Bearna West Roundabout	Existing R336 can be busy, especially at weekend and during holiday season	Increase in traffic on this section, but mainly during week days	Slight negative	Long term	Medium	None proposed	Slight negative
Journey amenity (traffic-related)	Browne Roundabout & Seamus Quirke Road	Regular congestion at these locations particularly during peak hours and weekends	Transfer of a proportion of traffic to the proposed road development and reduced risk of congestion	Moderate positive	Long term	Very many	Implementation of GTS measures to improve journey amenity for pedestrian and cyclists	Significant positive
Journey amenity (traffic-related)	Kirwan Roundabout	Regular congestion at this location and at the Bodkin Roundabout	Transfer of a proportion of traffic to the proposed development and reduced risk of congestion	Slight-Moderate positive	Medium – long term	Very many	Opportunity to improve journey amenity for pedestrian and cyclists	Significant positive
Journey amenity (traffic-related)	N83 Tuam Road / existing N6 junction	Regular congestion at this location	Transfer of a proportion of traffic to the proposed road development, but also facilitating traffic on the proposed road development to the city centre via the N83 Tuam Road	Slight negative to Slight positive	Medium – long term	Very many	None proposed	Slight negative to Slight positive
Journey amenity (traffic-related)	Lynch Junction and Doughiska Junction	Regular congestion at these locations	Transfer of a proportion of traffic to the proposed development and reduced risk of congestion	Moderate-significant positive	Medium – long term	Very many	Opportunity to improve journey amenity for pedestrian and cyclists	Moderate positive

AMENITY – Journey amenity								
Nature of Impact	**Location / Sub-Group**	**Current situation**	**Operational Impact**	**Significance**	**Duration**	**Scale**	**Proposed Mitigation**	**Residual Impact**
Journey amenity (views)	River Corrib Bridge	N/a	Elevated view for drivers north and south of the River Corrib Corridor including of Menlo Castle	Moderate positive	Long term	Very many	-	Moderate positive-

AMENITY – General amenity								
Nature of Impact	Location / Sub-Group	Current situation	Operational Impact	Significance	Duration	Scale	Proposed Mitigation	Residual Impact
General amenity (environmental)	Cappagh Road and Ballymoneen Road	Quiet rural area. Scattered residential development with suburban development to south	Impacts on general amenity due to increased traffic volumes	Significant negative	Long term	Medium	Screen planting and noise mitigation where required. Refer also to **Chapter 12, Landscape and Visual** and **Chapter 17, Noise and Vibration**	Moderate negative
General amenity (environmental)	Northern link from Letteragh Junction	Scattered residential development	Impacts on general amenity due to noise or visual intrusion	Significant negative	Long term	Few	Screen planting and noise mitigation where required. Refer also to **Chapter 12 Landscape and**	Moderate to Significant negative

AMENITY – General amenity								
Nature of Impact	Location / Sub-Group	Current situation	Operational Impact	Significance	Duration	Scale	Proposed Mitigation	Residual Impact
							Visual and **Chapter 17, Noise and Vibration**	
General amenity (environmental)	Bushypark & Aughnacurra	Residential development	Impacts on general amenity due to noise or visual intrusion	Significant negative chapters	Long term	Medium	Screen planting and noise mitigation where required. Refer also to **Chapter 12, Landscape and Visual** and **Chapter 17, Noise and Vibration**	Moderate to Significant negative
General amenity (environmental)	St. James' National School, Bushypark	School and playing grounds	Impacts on general amenity due to noise or visual intrusion	Significant negative	Long term	Medium	Screen planting and noise mitigation where required. Refer also to **Chapter 12, Landscape and Visual** and **Chapter 17, Noise and Vibration**	Moderate negative
General amenity (environmental)	NUIG Sporting Campus	Sports pitches	Proposed road development on a viaduct splitting the sporting campus in two requiring a reconfiguration of	Very Significant negative	Long term	Many	Provision of a floodlit 3G GAA pitch, a floodlit 3G	Very significant but can be reduced to

AMENITY – General amenity								
Nature of Impact	Location / Sub-Group	Current situation	Operational Impact	Significance	Duration	Scale	Proposed Mitigation	Residual Impact
			pitches, the modification of the sports pavilion and a new Sporting Campus Plan and Strategy				training area and associated infrastructure for such as drainage of these pitches, as ball-stop netting and modification of the sports pavilion.	moderate subject to appropriate master planning. Subject also to financial compensation as part of the compulsory purchase process
General amenity (environmental)	River Corrib and river banks	Riverside walk and Menlo Castle	Noise and visual impacts from proposed river bridge	Significant negative	Long term	Medium	Retain existing vegetation. Noise barriers. Refer also to **Chapter 12, Landscape and Visual** and **Chapter 17, Noise and Vibration**	Significant negative
General amenity	School Road, Castlegar	Narrow road used partly as a commuting rat-run and with discontinuous roadside footpaths.	Transfer of ‘rat run’ traffic from School Road to the proposed road development	Slight positive	Long term	Medium	Overbridge on School Road to include footpath and extend to at least to tie-in with existing road	Moderate positive

AMENITY – General amenity								
Nature of Impact	Location / Sub-Group	Current situation	Operational Impact	Significance	Duration	Scale	Proposed Mitigation	Residual Impact
General amenity	Mass path Parkmore	Quiet and well-maintained footpath elevated above surrounding area	Severance of path, but with new connectivity and informal crossing facility, but also loss of amenity value	Significant negative. (Positive on connectivity)	Long term	Few	Screen planting	Significant negative (Positive on connectivity)
General amenity (environmental)	Galway Racecourse	Horse racing	Proposed road development placed in tunnel beside racecourse. Improved access and reduced congestion.	Slight positive	N/a	Very many	N/a	Slight positive

SEVERANCE								
Nature of Impact	**Location / Sub-Group**	**Current situation**	**Operational Impact**	**Significance**	**Short / Long term / perm**	**Scale**	**Proposed Mitigation**	**Residual Impact**
Relief from severance	Bearna Village	Some severance in the centre of the village especially at peak times	Transfer of much traffic to the proposed road development	Significant positive	Long term	Medium	-	Significant positive
New severance and relief from severance	Na Foraí Maola and Troscaigh	Rural area with scattered linear residential development	Social and physical severance. Foraí Maola road diverted to Troscaigh Junction. But also positive impact of new connection with Troscaigh	Moderate negative. Moderate positive	Long term	Few	Diversion of local road included in design	Moderate negative. Moderate positive
New severance	L13215 Ann Gibbons Road	Rural area with scattered linear residential development	Road severed. Most community facilities to south, but north bound traffic will now have to divert south and to the Bearna Moycullen Road	Significant negative for householders on northern end of the Ann Gibbons Road	Long term	Few	-	Significant negative
New severance	North of Bearna Village	Rural area with scattered linear residential development	Crossing facilities mitigate physical severance, but psychological severance created between areas to north and south	Moderate negative	Long term	Many	Include pedestrian crossing facilities at junctions	Slight negative
New severance	Cappagh Road	Low traffic volumes	Higher traffic volumes presenting new severance at sports pitches to south	Moderate negative	Long term	Medium	Crossing facilities in place, but impact outside of area of-proposed road development	Moderate negative
New severance	Gort na Bró Miller’s Lane	Light traffic	Some additional traffic	Slight negative	Long term	Medium	None proposed	Slight negative

SEVERANCE								
Nature of Impact	**Location / Sub-Group**	**Current situation**	**Operational Impact**	**Significance**	**Short / Long term / perm**	**Scale**	**Proposed Mitigation**	**Residual Impact**
New severance	Coolagh and Menlough	Narrow rural roads	Degree of new social severance due to presence of proposed road development	Slight negative	Long term	Medium	-	Slight negative
New severance	N84 Headford Road to existing N6	Moderate traffic volumes	Increase in traffic accessing proposed N84 Headford Road Junction and physical presence of junction	Moderate negative	Long term	Medium	Provide pedestrian crossing facilities at community facilities.	Slight negative

ECONOMIC								
Nature of Impact	**Location / Sub-Group**	**Current situation**	**Operational Impact**	**Significance**	**Short / Long term/ permanent**	**Scale**	**Proposed Mitigation**	**Residual Impact**
Passing trade	R336 and Bearna	Some passing trade including for service stations on R336 Coast Road / Tuam Road	Reduction in passing traffic but improved access to premises	Slight negative	Long term	Few	None proposed	Slight negative
Access	Gateway Business Park	Access via Seamus Quirke Road subject to regular congestion	Alternative of more direct access to proposed road development	Significant positive	Long term	Medium	-	Significant positive
Access	N59 Moycullen Road &	Business park access via N59 Moycullen Road subject to congestion and indirect access to existing N6.	Alternative of access to proposed road development via link road	Significant positive	Long term	Medium	-	Significant positive

ECONOMIC								
Nature of Impact	**Location / Sub-Group**	**Current situation**	**Operational Impact**	**Significance**	**Short / Long term/ permanent**	**Scale**	**Proposed Mitigation**	**Residual Impact**
	Newcastle Road Upper							
Access	Car dealership and postal centre on the N83 Tuam Road	Direct access on to busy N83 Tuam Road	Improved access to N83 Tuam Road from start of City North Business Park Link. Good visibility of businesses maintained	Moderate positive	Long term	Two businesses	-	Moderate positive
Access	Parkmore Business Park, City East and Ballybrit Industrial Estates	Limited access between the Parkmore Business Park, the N83 Tuam Road and the existing N6.	Much improved access to N83 Tuam Road and proposed road development	Profound positive	Long term	Very many	-	Profound positive
General economic	Galway Racecourse	Access via existing N6 and event day access to N83 Tuam Road	Requirement to replace stables and other facilities. Proposed tunnel to the north of the racetrack. Improved general access, including to the N83 Tuam Road	Net moderate positive	Long term	One major business and ancillary businesses , including during events	-	Net moderate positive
Access	Briarhill Business Park	Access to existing N6	Reduced congestion expected at Ballybrit Crescent and Lynch Junction. New access north to N83 Tuam Road via Parkmore Link Road	Significant positive	Long term	medium	-	Significant positive

ECONOMIC								
Nature of Impact	**Location / Sub-Group**	**Current situation**	**Operational Impact**	**Significance**	**Short / Long term/ permanent**	**Scale**	**Proposed Mitigation**	**Residual Impact**
Access, land take	Car dealership, Briarhill Business Park	Access to existing N6	Reconfiguration of services on the residual lands are required with improved access with the reduced congestion on the existing road network	Negative impact from landtake combined with some positive impact from improved access	Long term	One business	Provide directional signage	Subject to financial compensation as part of the compulsory purchase process
Tourism	Galway City and locations to west	High congestion in city and poor connectivity to Connemara	Reduced congestion and improved connectivity	Very significant positive	Long term	Very many	-	Very significant positive

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19 Major Accidents, Inter-Relationships, Interactions and Cumulative Impacts

19.1 Introduction

This chapter of the EIAR presents an assessment of the vulnerability of the proposed road development to risks of major accidents and/or disasters including the methodology used for the assessment (**Section 19.2**). The methodology used to assess interaction/inter-relationship and cumulative impacts is presented in **Section 19.3**, with the assessment of the interaction/inter-relationship of impacts between the various environmental factors as a result of the proposed road development in **Section 19.4** and an assessment of the cumulative impacts of the proposed road development with other projects in **Section 19.5**. Potential transboundary impacts are included in **Section 19.6** and this chapter concludes with references (**Section 19.7**).

19.1.1 Vulnerability of the proposed road development to risks of major accidents and/or disasters

Article 3 of the EIA Directive as amended by Directive 2014/52/EU requires that:

"The effects referred to in paragraph 1 on the factors set out therein shall include the expected effects deriving from ***the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned****".*

Furthermore, Annex IV (8) (*Information Referred to in Article 5(1) (Information for the Environmental Impact Assessment Report*) of the EIA Directive as amended by Directive 2014/52/EU states that the EIAR shall contain:

"A description of the expected significant adverse effects of the project on the environment deriving from the ***vulnerability of the project to risks of major accidents and/or disasters which are relevant to the project concerned****. Relevant information available and obtained through risk assessments pursuant to Union legislation such as Directive 2012/18/EU of the European Parliament and of the Council[1]or Council Directive 2009/71/Euratom[2] or relevant assessments carried out pursuant to national legislation may be used for this purpose provided that the requirements of this Directive are met.* ***Where appropriate, this description should include measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies****."*

[1] (*) Directive 2012/18/EU of the European Parliament and the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (OJ L 197, 24.7.2012, p. 1).

[2] (**) Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations (OJ L 172, 2.7.2009, p. 18)'.

Section 19.2 of this chapter presents an assessment of the vulnerability of the proposed road development to risks of major accidents and/or disasters which are relevant to the proposed road development.

19.1.2 Interactions and Inter-relationships

Article 3 (1) of the EIA Directive as amended by Directive 2014/52/EU requires that:

"The environmental impact assessment shall identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on the following factors: (a) population and human health; (b) biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC; (c) land, soil, water, air and climate; (d) material assets, cultural heritage and the landscape; ***(e) the interaction between the factors referred to in points (a) to (d)****.*

Also, pursuant to section 50(3)(b) of the Roads Act 1993 (as amended) the EIAR (or EIS as then was under the Roads Act) is to contain:

"50(3)(b) a description of the aspects of the environment likely to be significantly affected by the proposed road development, including in particular—

- *human beings, fauna and flora,*
- *soil, water, air, climatic factors and the landscape,*
- *material assets, including the architectural and archaeological heritage, and the cultural heritage,*
- *the inter-relationship between the above factors,*

The interaction of effects within the proposed road development in respect of each of the environmental factors, listed in Article 3(1) of the EIA Directive, have been identified and addressed in detail in the respective chapters in this EIAR. This chapter however, presents a summary of each assessment of the interaction (inter-relationship) of impacts, from the proposed road development, between the various environmental factors.

Section 19.4 of this chapter presents an assessment of the interaction/inter-relationship of impacts between the various environmental factors as a result of the proposed road development.

19.1.3 Cumulative Impacts

Annex IV (5)(e) of the EIA Directive as amended by Directive 2014/52/EU requires that the EIAR shall contain:

"*A description of the likely significant effects of the project on the environment resulting from, inter alia:*

(e) the ***cumulation of effects*** *with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;*

Furthermore, Annex IV (5) states that the EIAR shall contain:

"The description of the likely significant effects on the factors specified in Article 3(1) should cover the direct effects and any indirect, secondary, ***cumulative****, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative effects of the project. This description should take into account the environmental protection objectives established at Union or Member State level which are relevant to the project".*

Also, pursuant to section 50(3)(c) of the Roads Act 1993 (as amended) the EIAR (or EIS as then was under the Roads Act) is to contain:

"(c) a description of the likely significant effects (including direct, indirect, secondary, ***cumulative****, short, medium and long-term, permanent and temporary, positive and negative) of the proposed road development on the environment resulting from—*

- *the existence of the proposed road development,*
- *the use of natural resources,*
- *the emission of pollutants, the creation of nuisances and the elimination of waste"*

Section 19.5 of this chapter presents an assessment of the cumulative impacts of the proposed road development with other projects.

19.2 Major Accidents and Disasters

19.2.1 Introduction

This section presents an assessment of the likely significant adverse effects of the proposed road development on the environment arising from the vulnerability of the proposed road development to risks of major accidents and/or disasters that are relevant to the proposed road development.

As mentioned previously, this assessment is necessary following changes to the EU legislation. Article 3 of the EIA Directive as amended by Directive 2014/52/EU states the need to assess "*the expected significant adverse effects of the project on the environment deriving from the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned*".

The underlying objective of the assessment is to ensure that appropriate precautionary actions are taken for those projects which "*because of their vulnerability to major accidents and/or natural disasters, are likely to have significant adverse effects on the environment"*.

Based on the requirements of the new EIA Directive, this chapter answers the following questions:

- To what major accidents and/or disasters could the proposed road development be vulnerable?
- Could these major accidents and/or disasters result in likely significant adverse environmental effect(s) and if so what would these be?

- What measures are in place, or need to be in place, to prevent or mitigate the likely significant adverse effects of such events on the environment?

This assessment is set out as follows:

- **Section 19.2.2** sets out the methodology used
- **Section 19.2.3** describes characteristics of the major accidents and/or disasters that may be relevant to the proposed road development
- **Section 19.2.4** details the risk screening process to determine what major accidents and/or disasters to which the proposed road development could be vulnerable
- **Section 19.2.5** provides a summary of the output of the risk screening process
- **Section 19.2.6** details the assessment of the vulnerability of the proposed road development to major accidents and/or disasters identified during the risk screening process
- **Section 19.2.7** describes measures to mitigate the likely significant impacts of such events on the environment
- **Section 19.2.8** describes residual impacts
- **Section 19.2.9** provides a summary

19.2.1.1 Key definitions relevant to this assessment

At the time of undertaking this assessment, there was no clear definition of the term "major accident and/or disaster" in the context of the EIA Directive. Achieving a common terminology is a challenge as various disciplines have developed specific terminology for the assessment of risks and impacts. The following definitions have been adopted for this EIAR following a review of SEC (2010) 1626 – Risk Assessment and Mapping Guidelines for Disaster Management and ISO 31010 – Risk Management.

Hazard is a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (*in technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis*).

Natural hazard: Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (*natural hazards are a sub-set of all hazards. The term is used to describe actual hazard events as well as the latent hazard conditions that may give rise to future events. Natural hazard events can be characterised by their magnitude or intensity, speed of onset, duration, and area of extent (UNISDR, 2009)*).

Disaster risk[3] is characterised as a hazard which has potential to incur community losses, encompassing assets, life, health and livelihoods, giving significance to disaster events at a personal and local scale. Disaster risk can also be defined as, hazards which could cause a locality to require assistance from an outside state, which could relate to international aid, or a local authority requiring assistance from another local authority.

A *natural disaster*, in the context of the proposed road development, is a naturally occurring phenomenon such as an extreme weather event (e.g. storm, flood, temperature) or ground-related hazard events (e.g. subsidence, landslide, earthquake) with the potential to cause an event or situation that meets the definition of a major accident as defined above.

Accident is an undesirable event resulting in damage or harm. Natural disaster events refer to natural occurrences, and are not defined to include events caused by humans (however natural events can be exacerbated by human intervention – development exacerbating flooding etc.). This gives reason to the inclusion of both terms 'accident' and 'disaster' within the Directive to ensure there is certainty that both man-made and naturally caused hazards are considered.

Vulnerability is defined as the 'exposure and resilience' of the proposed road development to the risks associated with major accidents and/or disasters. Vulnerability is influenced by sensitivity, adaptive capacity, and magnitude of impact (*the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. (UNISDR, 2009)*).

Low likelihood is defined for the purposes of this assessment, as events that may occur during the lifetime of the proposed road development, so no more than once for the construction phase, and no more than once for the operational phase. The construction period of the proposed road development has been estimated at three years, the minimum operational period can be estimated at 120 years as this is the design life of the structures per DN-STR-03012 (Design For Durability).

The following definition has been derived from *S.I. No. 209/2015 - Chemicals Act (Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2015 (COMAH Regulations 2015)* and the *Framework for Major Emergency Management* prepared by the National Steering Group in Ireland for Major Emergency Management:

A *major accident*, in the context of the proposed road development, is defined as an event that threatens immediate or delayed serious damage to human health, welfare and/or the environment and requires the use of resources beyond those of the road authority or its contractors. Serious damage includes the loss of life or permanent injury and/or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts. The significance of this effect takes into account the extent, severity and duration of harm and the sensitivity of the receptor.

[3] Risk is a combination of the consequences of a hazard (event) and the associated likelihood/probability of its occurrence.

19.2.2 Methodology

19.2.2.1 Introduction

The starting point for the scope and the methodology of this assessment is that the proposed road development is designed and will be built and operated in accordance with best practice. Ensuring that the proposed road development is designed safely and will thus operate safely has been to the forefront of the design process. Additionally, at the forefront of the design process was the need to ensure that the proposed road development is capable of being constructed safely and without risk to health, can be maintained safely, and complies with all relevant health and safety legislation. This approach has allowed all identified risks to be managed such that, where possible, the hazards that result in risks are mitigated (manage hazard source, manage pathway between source and receptor, manage receptor) or eliminated (eliminate source, remove pathway between source and receptor, remove receptor).

The methodology for assessing the vulnerability of the proposed road development to risks associated with major accidents and/or disasters is a risk analysis based approach and is based directly on the requirements of the new EIA Directive (2014/52/EU), the draft 2017 EPA Guidelines on the Information to be contained in Environmental Impact Assessment Reports, Draft, August 2017 and the European Commission (2017) Environmental Impact Assessment of Projects – Guidance on the preparation of the Environmental Impact Assessment Report. (Office for Official Publications of the European Communities 2017).

This risk analysis based approach is derived from documentation prepared by the European Commission such as:

- The Risk Assessment and Mapping Guidelines for Disaster Management[4]
- Directive 2007/60/EC (EU Floods Directive)
- Directive 2008/96/EC (Road Infrastructure Safety Management)
- Directive 2004/54/EC (minimum safety requirements for tunnels in the Trans-European Road Network)
- Directive 91/689/EEC (on hazardous waste)
- Directive 2012/18/EU (control of major-accident hazards involving dangerous substances)
- Directive 2000/60/EC (EU Water Framework Directive)
- Directive 2006/118/EC (Groundwater)

The assessment covers the identification of potential hazards associated with major accidents and/or disasters, their likelihood, and the potential resulting consequences thereof. The assessment has focused on three main areas:

- Consideration of the vulnerability (exposure and resilience) of the proposed road development to risks of major accidents/and or disasters

[4] European Commission, Commission Staff Working Paper, SEC(2010) 1626 final.

- Identification of the types of major accidents and/or disasters that are relevant to the proposed road development and the likelihood of their occurrence
- Description of the expected significant adverse effects of the proposed road development on the environment (environmental factors) arising from the vulnerability of the proposed road development to risks of major accidents and/or disasters

Eliminating, isolating and mitigating identified risks was undertaken during the design and environmental evaluation process for the proposed road development. Design and mitigation measures identified and included to reduce or avoid risks of major accidents and/or disasters are considered to be part of the design, as they reduce the likelihood and consequence of risk events, for the purposes of this assessment. Such measures are detailed within **Section 19.2.4**.

19.2.2.2 Legislation and Guidelines

The following paragraphs set out the requirements of the EIA Directive as amended by Directive 2014/52/EU in relation to major accidents and/or disasters.

Article 3 of the EIA Directive as amended by Directive 2014/52/EU

"The effects referred to in paragraph 1 on the factors set out therein shall include the expected effects deriving from ***the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned****".*

Furthermore, Annex IV (8) (*Information Referred to in Article 5(1) (Information for the Environmental Impact Assessment Report*) of the EIA Directive as amended by Directive 2014/52/EU states that the EIAR shall contain:

"A description of the expected significant adverse effects of the project on the environment deriving from the ***vulnerability of the project to risks of major accidents and/or disasters which are relevant to the project concerned****. Relevant information available and obtained through risk assessments pursuant to Union legislation such as Directive 2012/18/EU of the European Parliament and of the Council[5]or Council Directive 2009/71/Euratom[6] or relevant assessments carried out pursuant to national legislation may be used for this purpose provided that the requirements of this Directive are met.* ***Where appropriate, this description should include measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies.****"*

Furthermore, Recital 15 of the EIA Directive as amended by Directive 2014/52/EU states that:

"(15) In order to ensure a high level of protection of the environment, precautionary actions need to be taken for certain projects which, because of their vulnerability to major accidents, and/or natural disasters (such as flooding, sea

[5] (*) Directive 2012/18/EU of the European Parliament and the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (OJ L 197, 24.7.2012, p. 1).
[6] (**) Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations (OJ L 172, 2.7.2009, p. 18)'.

level rise, or earthquakes) are likely to have significant adverse effects on the environment. For such projects, it is important to consider ***their vulnerability (exposure and resilience) to major accidents and/or disasters, the risk of those accidents and/or disasters occurring and the implications for the likelihood of significant adverse effects on the environment****. In order to avoid duplications, it should be possible to use any relevant information available and obtained through risk assessments carried out pursuant to Union legislation, such as Directive 2012/18/EU of the European Parliament and the Council*[7] *and Council Directive 2009/71/Euratom*[8]*, or through relevant assessments carried out pursuant to national legislation provided that the requirements of this Directive are met."*

The requirement to assess the vulnerability of a development to risks associated with major accidents and/or disasters is also referenced in the draft 2017 EPA *Guidelines on the information to be contained in an EIAR* as follows:

"*To address unforeseen or unplanned effects the Directive further requires that the EIAR takes account of the vulnerability of the project to risk of major accidents and /or disasters relevant to the project concerned and that the EIAR therefore explicitly addresses this issue. The extent to which the effects of major accidents and / or disasters are examined in the EIAR* ***should be guided by an assessment of the likelihood of their occurrence (risk). This may be supported by general risk assessment methods or by systematic risk assessments required under other regulations e.g. a COMAH (Control of Major Accident Hazards involving Dangerous Substances) assessment***".

19.2.2.3 Data sources and Consultations

A desktop study of environmental assessments undertaken by each of the specialists who contributed to the preparation of this EIAR was completed. Each environmental specialist considered routine events (those predicted to happen or which are likely to happen) and non-routine events (which 'might' happen) in their assessment of likely significant effects on the environment and provided mitigation measures to eliminate or reduce the risk to the lowest degree possible. The assessment in this chapter makes reference to these assessments where relevant rather than duplicating them. Therefore, this chapter only considers low likelihood but potentially high consequence events. The screening process to determine low likelihood but potentially high consequence events associated with major accidents and/or disasters is set out in **Sections 19.2.2.4** below.

Key to comprehensively understanding the potential consequences of major accidents and disasters in the context of the proposed road development was gaining an understanding of common region-specific accident and/or disasters events. In particular, it was necessary to identify the factors that result in natural disasters. Therefore, emergency service organisations, local authority personnel, and regional authority personnel responsible for responding to and coordinating the response to

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[7] Directive 2012/18/EU of the European Parliament and the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (OJ L 197, 24.7.2012, p. 1).

[8] Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations (OJ L 172, 2.7.2009, p. 18).

the fallout of major accidents and/or disasters, and indeed for the future planning of responses to such incidents were consulted.

The following emergency service providers and local and regional authorities were consulted:

- Galway City Council
- Galway County Council
- Galway County Council fire department
- An Garda Síochána traffic corps
- An Garda Síochána operations
- Department of Defence
- Health Service Executive – emergency management
- Major Emergency Group West Region

This consultation, as expected, highlighted that weather events are the principal hazards encountered with respect to road operation in the region - be it rainfall, wind, or icy conditions and their potential contribution to natural disasters such as landslides and ground subsidence and major accidents such as vehicular collisions.

In conjunction with local, regional, and emergency organisations, means of enhancing the resilience of the proposed road development to major accident and disaster events were discussed. Such discussions focused on the provision of access to the proposed road development, the provision of warning systems to warn users of incidents in advance of hazards, and the management and operation of the proposed road development.

19.2.2.4 Assessment Methodology

The potential for hazards associated with major accidents and/or disasters to result in a significant adverse environmental effect was assessed. The approach adopted considers hazards that may produce environmental consequences, the likelihood of these consequences occurring, considering planned mitigation, and the acceptability of the subsequent risk to the receiving environment. The process included:

- identifying hazards
- screening these hazards
- defining the impact
- assessing the likelihood of occurrence
- assessing the remaining risks

The assessment was undertaken at a route-wide level but, where relevant, reflects locations that were considered more vulnerable to risks associated with identified potential major accidents and/or disasters.

The key features underlying the assessment of the vulnerability of the proposed road development to major accident and/or disaster risk events are that:

- only risks with a feasible source-pathway-receptor model were considered as part of the appraisal
- tunnels proposed as part of the proposed road development are classified as Category C in accordance with *European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR).* This limits access to the proposed road development to materials of Class C and lesser thus limiting the unrestricted carriage of classes of dangerous goods

In terms of the assessment methodology, the following approach has been adopted:

- no additional risk modelling was undertaken for this assessment. Instead, the risk modelling and the analysis completed as part of the design and environmental evaluation of the proposed road development were utilised
- the assessment was completed via a review of available documentation and legal and regulatory requirements
- where information was not available, reference and regard was had to existing empirical information. For example, regard was had to empirical information regarding collision rates associated with single carriageway and motorway projects. Such information was then utilised to determine safety benefits consequent to the development of the proposed road development

Identification of Environmental Receptors

The assessment considered human beings, population and health, biodiversity, land, soil, water, air quality and climate, noise and vibration, material assets (both agriculture and non-agriculture), archaeology, architecture and cultural heritage, and the landscape, and interactions of these factors as per the requirements of the EIA Directive and the draft 2017 EPA Guidelines. For the purpose of assessment, an environmental receptor was therefore considered to be any of these. Relevant environmental receptors for this assessment therefore included:

- members of the public and local communities
- infrastructure and the built environment (including material assets)
- the natural environment, including ecosystems, land and soil quality, air quality and climate, noise and vibration, surface and groundwater resources, and landscape
- the historic environment, including archaeology and architectural and cultural heritage

Factors considered in determining whether potential adverse effects are significant included:

- the geographic extent of the effects. Effects beyond the extents of the proposed development are considered significant
- the duration of the effects. Effects which are permanent (i.e. irreversible) or long lasting are considered significant

- the severity of the effects in terms of number, degree of harm to those affected and the response effort required. Effects which trigger the mobilisation of substantial civil emergency response effort are considered significant
- the sensitivity of the identified receptors
- the effort required to restore the affected environment. Effects requiring substantial clean-up or restoration efforts are considered significant

For the proposed road development, a significant adverse effect is considered to mean the loss of life or permanent injury, and/or permanent or long-lasting damage to an environmental receptor. The significance of this effect takes into account the extent, severity, duration of harm, and the sensitivity of the receptor.

Identification and Screening of Risks

Risk identification involved collating data from existing sources of information and collating risks identified during design and environmental evaluation process.

To identify whether a risk has the potential for a significant adverse effect on an environmental receptor or for death or permanent injury, three components needed to be present: a source, a pathway (between source and receptor) and a receptor. As such, the assessment uses the following conceptual model:

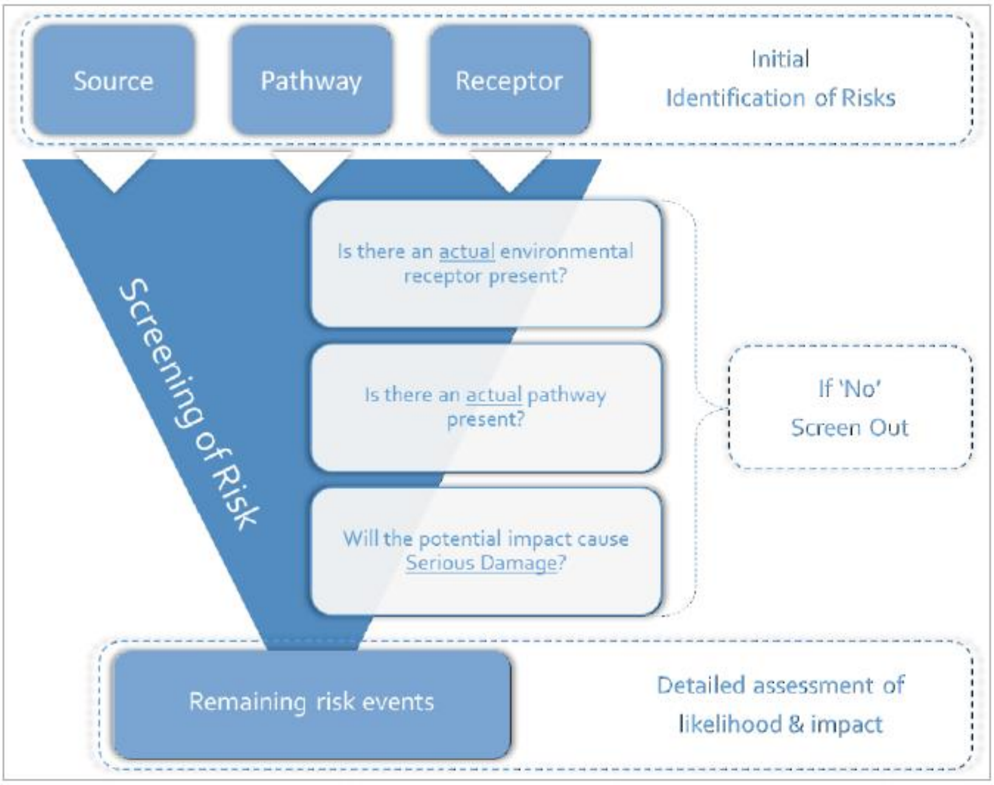
- the source is the original cause of the hazard, which has the potential to cause harm, for example a vehicle travelling on the proposed road development or adverse weather events
- the pathway is the route by which the source can reach the receptor, for example a vehicular accident or flooding
- the receptor which is the specific component of the environment that could be adversely affected if the source reaches it (e.g. environmental habitat damaged via vehicular accident or flooding, loss of life due to vehicular accident or flooding)

Risk events which do not have all three components were screened out from the assessment.

The following screening process was used to identify those risk events requiring further consideration within the assessment (**Plate 19.1**):

- is there a potential source, pathway and receptor? If not, no further assessment required
- is there a relevant environmental receptor present in the locations where the risk event could occur, and a pathway whereby the source of harm can reach the receptor? If not, no further assessment required
- does the potential impact on the environmental receptor meet the definition of a significant adverse effect? If not, no further assessment required

Plate 19.1: Risk Screening Process



For those risk events which were not screened out during this three-step process, the following steps were followed:

- Define impact for each remaining risk event
- Access likelihood of remaining risk events occurring
- Access likely significant impact
- Appraise risk management options

This then formed the basis for recommending additional mitigation measures, if any, as appropriate.

Define impact for each remaining risk event

The worst case impact(s) on environmental receptors was identified for each event which remained, determined where necessary by consultation with relevant environmental specialists to answer the question

> *'could this event constitute a major accident or disaster in terms of the definitions provided?'*

Assess Likelihood of remaining risk events occurring

The likelihood of the reasonable worst case environmental effect(s) occurring was then evaluated taking into account:

- the likelihood of the risk event occurring considering the measures already embedded into the design, proposed mitigation measures and the execution of the proposed road development
- the likelihood that an environmental receptor could be affected by the risk event

Likelihood assessments were not always quantitative. However, all assessments evaluated whether the effect (for example, loss of life) was a possible outcome of the risk event.

This evaluation of the likelihood refers to existing assessments as well as risks identified through consultation with relevant environmental specialists, emergency service providers and local authority personnel responsible for major accident and disaster response, with reference to the definition of low likelihood but high consequence events.

Assess likely significant impact

The events not screened out are assessed in **Section 19.2.6**. The assessment of the events which remained following the screening process is presented in an Environmental Risk Record (**Table 19.1**). This record details the impact (the reasonable worst consequence if the hazard occurred), assesses the likelihood of the hazard occurring, and assesses the consequent risk. As part of this assessment embedded mitigation which reduces the hazard, the likelihood of the hazard, and significance of the potential risk consequent to the hazard is detailed. Ultimately it will be determined whether the risk could constitute a major accident and/or disaster and, if so, whether the risk has been mitigated to the greatest degree possible.

Appraise Risk Management Options

The risks that could not be screened out and reached this final step in the assessment process are low probability but potentially high consequence events. They are events which cannot feasibly be mitigated in the design or eliminated completely. For this reason, they are events for which the feasible method of mitigating against them lies in developing procedures to manage their potential consequences.

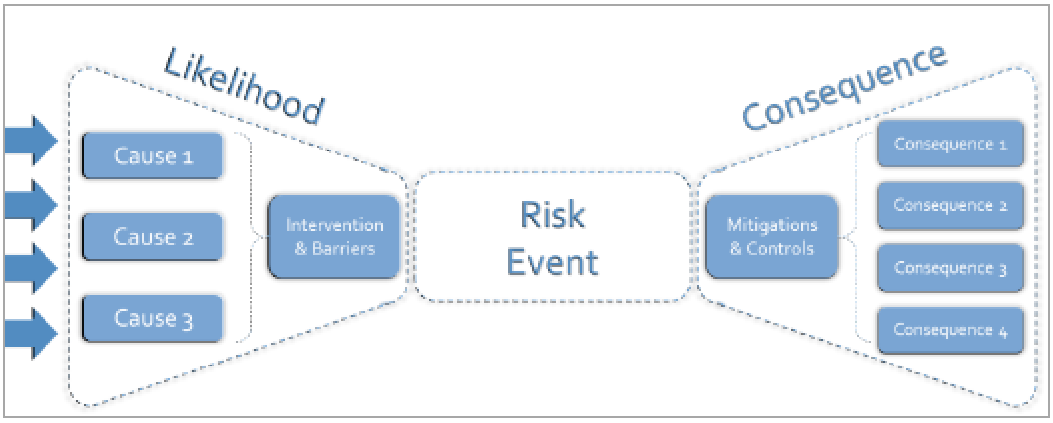
The mitigation hierarchy used as part of this assessment is as follows:

- adapt proposed processes such that either the likelihood or the impact of the risk event is reduced
- control the risk, by ensuring that appropriate control measures are in place (e.g. emergency response) so that if a risk event should occur, it can be controlled and managed appropriately

As noted, eliminating, isolating and mitigating identified risks was undertaken during design and environmental evaluation process for the proposed road development. Measures were identified and included to reduce or avoid risks associated with major accidents and/or disasters and included as part of the design considered in this assessment. Risk management measures considered following the screening process outlined above cannot therefore be classified as embedded, and consequently that is why they are limited to adapting processes to mitigate the consequence of risks and controlling the risks events as best possible.

Plate 19.2 shows the principles of managing risk, where measures to prevent a risk event occurring are barriers or intervention measures, or mitigation measures and putting controls in place should an event occur (for example, firewater containment measures).

Plate 19.2: Principles of Managing Risk



19.2.3 Characteristics of Major Accidents and / or Disasters

The major accidents and disasters considered in this assessment are low likelihood but potentially high consequence events (major accidents and/or disasters).

All low consequence events, whatever their likelihood, do not meet the definition of major accidents and/or disasters. For example, minor spills, silt control, and dust emissions which may occur during construction, but would be limited in area and volume and temporary in nature do not meet the definition of a major accident and/or disaster. Such events have already been considered and mitigated for as part of the design of the proposed road development.

Low likelihood is defined for the purposes of this assessment, as events that may occur during the lifetime of the proposed road development, so no more than once for the construction phase, and no more than once for the operational phase. The construction period of the proposed road development has been estimated at three years, the minimum operational period can be estimated at 120 years as this is the design life of the structures per DN-STR-03012 (Design For Durability). 120 years is not an upper boundary for low likelihood. Very low likelihood events are also included in the assessment, for example flood events which may only occur at most once in every 1,000 years (Flood Risk Assessment). Measures were incorporated into the design to reflect what is reasonable for such events, considering their potential consequence.

19.2.4 Risk Screening Process

This section details the Screening Process and the conclusions of assessments undertaken as part of the design and environmental evaluation process. These earlier assessments took cognisance of the design measures and mitigation measures included to reduce the significance of risks associated with major accidents and/or natural disasters. Risks are screened such that only low likelihood but potentially high consequence events remain. **Section 19.2.5** then details the assessment of these remaining risk events.

Regard has been had to the requirements of the Eurocodes with respect to structural and geotechnical design requirements. Utilisation of the Eurocodes manages the hazards and consequent risks associated with natural disasters (seismic activity, ground related movements). Their utilisation ensures that high quality resilient designs are produced.

Aside from structural and geotechnical design, all other design has been completed in accordance with best practice and national standards (for example, TII Publications). Reference to such standards are provided below as required.

Regard has been had to the requirements of the EIA Directive, the draft 2017 EPA guidelines, and documentation prepared by the European Commission as detailed in **Section 19.2.2**. Documentation prepared by the European Commission, in particular the Directives noted, place an emphasis on ensuring that proposed developments are resilient and safe. Their utilisation ensures that high quality resilient designs are produced thereby ensuring that the vulnerability of the proposed road development to risks associated with major accidents and/or disasters is minimised to the greatest degree possible.

19.2.4.1 Safety

As noted previously, ensuring that the proposed road development is designed safely and will thus operate safely has been to the forefront of design development. To regularise and embed this principle within design development, safety assessments were undertaken for the proposed road development to inform the identification and assessment of hazards and consequent risks. Assessments included health and safety design risk assessments in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013, design reviews, and safety assessments undertaken as part of the transport appraisal. The results of these assessments are enveloped within design of the proposed road development and environmental evaluation as detailed throughout this EIAR.

Regard was had to features external to the proposed road development which could contribute a potential source of hazard to the proposed road development. This information was obtained from a desk based study. Such features include, but are not limited to:

- Presence of Control of Major Accidents and Hazards (COMAH) sites
- Potentially hazardous ground conditions
- Proximity to other infrastructure (road, energy)

COMAH sites, and their associated risks, were scoped out of the assessment due to their distance from the proposed road development[9]. Additionally, the tunnels are proposed as tunnel Category C in accordance with ADR which imposes its own limitations with respect to the carriage of dangerous goods, often associated with COMAH sites, on the proposed road development.

Hazardous ground conditions were assessed as part of the ground conditions assessment above.

Proximity to other infrastructure, especially road infrastructure, was assessed via the preparation of a road safety impact assessment per TII PE-PMG-02001 (Road Safety Impact Assessment). The purpose of Road Safety Impact Assessment (RSIA) is to undertake a strategic comparative analysis of the impact on the safety performance of the road network of different planning alternatives for a new road or a substantial modification to the existing network. The requirements of TII PE-PMG-02001 and the assessments therein are derived from EU Directive 2008/96/EC on Road Infrastructure Safety Management (RISM). Issues highlighted (for example safety of vulnerable road users) as part of the RSIA were targeted for improvement as part of the project objectives.

19.2.4.2 Vehicle Usage

The proposed road development has been designed to accommodate vehicular traffic, thus, there is a consequent potential for vehicular accident events. The likelihood of such events is minimised to the greatest degree possible by designing the geometric layout of the proposed road development in accordance with national requirements (TII Publications) which contain criteria for achieving a desirable level of performance in terms of road safety, operational, economic and environmental effects, and sustainability. The geometric layout has been subjected to safety audits per TII GES-TY-01024 (Road Safety Audit). The purpose of such audits is to ensure that the road safety implications of the proposed road development is fully considered for all users of the road and other users affected by the development. The requirements of TII GES-TY-01024 and the assessments therein are derived from EU Directive 2008/96/EC (Road Infrastructure Safety Management (RISM)).

Vehicular accident events can be exacerbated by interaction with obstacles in the path of errant vehicles, similarly errant vehicles can exacerbate risk events – such as the risk of bridge collapse consequent to vehicular collision. A risk assessment was undertaken in accordance with GE-TBU-01010 (NRA BD2 Safety Barrier Risk Assessment) and GE-TBU-01019 (NRA TB 11 NRA TD 19 and Forgiving Roadsides). This assessment identified locations where it is necessary to provide vehicular restraint systems to reduce the severity and potential consequences of vehicular accident events, and consequently related events such as bridge strike events (bridge collapse) and errant vehicles interacting with sensitive environmental receptors (discharge of pollutants into sensitive groundwater receptors).

[9] The closest COMAH site Cold Chon, Oranmore is approximately 2.15km from the closest point of the proposed development boundary.

In addition to physical mitigation such as vehicle restraint systems, operational measures have been incorporated into the design which will act to mitigate the potential consequences of vehicle accident events such as a vehicle breakdown or fire. Access points have been provided that will enable efficient access for emergency services and make their response times more efficient and reduce the potential significance of consequences, i.e. any incidents will not be exacerbated by delayed response or the inability to access an event location.

Additionally, intelligent transport systems (communication and traffic control systems including variable messaging gantries, automatic barriers at tunnel entrances, real time monitoring and control of road traffic and flows, automatic incident detection in tunnels) have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure).

The proposed road development has been designed in accordance with best practice and includes measures as noted. However, there remains the possibility of vehicular accident events. The three components - source, pathway, and receptor remain. It is not possible to eliminate the source (vehicular traffic) and receptors (environmental receptor, human life). The pathway is restricted because of the restraint systems, though not eliminated. In addition, restraint systems themselves can act as hazards. They are included where the consequences of the vehicle striking the barrier are considered to be less serious than those that would result if the barrier were not in place. Such restraint systems will temper the consequences and likelihood of major accidents and/or disasters associated with vehicular accident events; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to vehicular accident events. This is the case as the loss of life or permanent injury cannot be categorically discounted.

It is therefore not possible to rule out low likelihood but potentially high consequence vehicle accident events and the vulnerability of the proposed road development to such events. Therefore, vehicular accidents are further assessed in **Section 19.2.5**.

19.2.4.3 Construction Activities

The proposed road development has been designed to ensure that it is capable of being constructed safely and without risk to health. Safe construction, and the preparation of method statements, will be the responsibility of the Contractor. Construction related hazards are capable of being managed where construction safe systems of work are implemented by the Contractor. The events identified within this section of the EIAR are equally applicable to construction and operation of the proposed road development.

In addition to the design measures and mitigation measures which are included to reduce the potential for impacting environmental receptors, a Construction Environmental Management Plan (CEMP) (see **Appendix A.7.5**) has been prepared which sets out measures to bolster the design and mitigation measures and further minimise the consequences and likelihood of impacting environmental receptors. This plan summarises the overall environmental management strategy to be adopted and implemented during the construction phase of the proposed road development.

It sets out the need to prepare an 'Incident Response Plan' during the construction phase. Such a plan would include measures to ensure that accidental spillages, sediment, erosion, and pollution do not impact on the receiving environment, consequently this plan sets out many of the mitigation and operational measures detailed in the foregoing chapters of this EIAR.

Post construction, the CEMP will be developed into an Environmental Operating Plan for the operational phase ensuring operational mitigation measures are enforced. This plan will be utilised by the road authority and will set out measures to ensure that accidental spillages, sediment, erosion, and pollution do not impact on receiving environment. Again, this reflects the operational mitigation measures detailed in this EIAR, in particular the Schedule of Environmental Commitments presented in **Chapter 20, Summary of Environmental Commitments and Residual Impacts**. The specific events which may arise during construction are screened within the following sections.

19.2.4.4 Tunnels and Bridges

Major accident and/or disaster events can be exacerbated by tunnels and their confined nature. Therefore, it was necessary to identify appropriate standards of safety and operational requirements for tunnels and incorporate them into the design of the proposed road development. In this respect requirements were derived from DN-STR-03015 (BD78/99 – Design of Road Tunnels) and EU Directive 2004/54/EC (minimum safety requirements for tunnels in the Trans-European Road Network)[10]. In accordance with DN-STR-03015 a Tunnel Design and Safety Consultation Group was established. Meetings were held with emergency service personnel to facilitate the contribution of their specific specialist knowledge and experience to determine requirements for tunnel design.

EU Directive 2004/54/EC (transposed into Irish Law by SI 213 of 2006) sets out minimum safety requirements for tunnels in the Trans-European Road Network and requires risk based analysis to steer tunnel design. The Directive sets out the requirement for managing the risks associated with fire events within tunnels. Following assessment as per the Directive, the risk level (for tunnels incorporated in the proposed road development) was determined to be low (Category C per ADR was determined, refer below). This determination steered the selection of design criteria. Design criteria selected ensure that the likelihood and consequence of events (including fire, operational, breakdown) are mitigated and managed. The following design measures, including measures for the operation of the tunnel are incorporated into the design of the proposed road development to mitigate the likelihood and consequence of events:

- the structural resistance to fire is a key aspect of any tunnel due to the high fire loads in such a confined environment. Design is required to rigorous fire curves. The tunnel structures have been designed to be capable of resisting the Rijkswaterstaat (RWS) fire curve for a minimum of 120 minutes. Provisions, such as fibre reinforced concrete or sacrificial cover, have also been included in the design to reduce the risk of spalling - a phenomenon whereby portions of

[10] Applicable to tunnels of length greater than 500m, notwithstanding regard was had to the requirements therein.

concrete fall off the tunnel lining during a fire therefore reducing the overall performance of the structure due to reduced concrete depth (thereby minimising the likelihood of collapse due to fire events)

- access to the tunnels has been provided for emergency services from each side to facilitate ease of access during any incidents
- emergency cross passages and walkways, to aid emergency egress, have been included per DN-STR-03015 (Design of Road Tunnels) at 100m spacing, this ensures that should risk events occur persons can exit the tunnel in a timely manner (thereby minimising the risk of persons becoming trapped within the affected bore)
- tunnel safety systems have been included in the design and will contribute to the management of the tunnel and will therefore assist in maintaining adequate levels of safety management. These include tunnel fire watermain, hose reels, traffic control measures (to forewarn motorists of incidents), automatic fire detection and alarm (warning emergency service providers to ensure a speedy response), automatic fire suppression, PA system, emergency lighting, safety signage, CCTV, and drainage systems for firefighting water and fuel spills (all runoff water collected to prevent discharge to sensitive environmental receptors)
- tunnel drainage systems have been designed to transfer spillages (hydrocarbons, chemicals) which may occur within the tunnel directly to a spillage containment area where it will be contained until it can be safely removed and disposed
- spillage containment areas are external to the tunnels allowing them to be managed in an open and safe environment as opposed to a confined environment
- regard was had to EU Directive 2004/54/EC regarding the carriage of dangerous goods. In this respect, regard was had to the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). Tunnel categorisation per ADR is based on the assumption that there are three major dangers in tunnels: (i) explosions, (ii) release of toxic gas or volatile toxic liquid and (iii) fires. The tunnel category, is assigned by the competent authority (Transport Infrastructure Ireland in Ireland) to a given road tunnel for the purpose of restricting the passage of transport units carrying dangerous goods. The recommended tunnel category for Lackagh Tunnel and Galway Racecourse Tunnel is 'C' in accordance with the ADR. The considerations which contributed to this are as follows:
    - Tunnel Category C requires that no article or substance which would be reasonably likely to explode, dangerously react, produce a flame or dangerous evolution of heat or produce dangerous emissions of toxic, corrosive or flammable gases or vapours are permitted to utilise the tunnel[11]
    - Tunnel Category C is recommended due to the expected low frequency of dangerous goods vehicles which would utilise the proposed road development due to the availability of alternative routes to accommodate same

[11] Reference to the ADR is required to identify gradation of consequences associated with various substances.

- Tunnel Category C is recommended as there would be a need and desire for heavy goods vehicles to use the tunnel to access retail and service industries throughout the city and county and therefore must be accommodated
- An advanced intelligent transport system will be implemented to control access to the entire network and in particular to the tunnels

Adopting Tunnel Category C as per ADR minimise the risks associated with the carriage of dangerous goods on the proposed road development and the potential hazards that may result in major accidents and/or disaster events.

As part of the design of the proposed road development the necessity to introduce mechanical ventilation in the design of the tunnels was considered. The need for such a measure was deemed unnecessary in accordance with the requirements of EU Directive 2004/54/EC and DN-STR-03015 (BD78/99 - Design of Road Tunnels). It was deemed unnecessary as the tunnels are less than 500m in length and facilitate natural ventilation.

Bridge strike events have also been considered as part of the risk assessment and the structural design of structural elements for the proposed road development has been undertaken in accordance with the Eurocodes and national design standards (TII Publications).

Structures incorporated into the proposed road development have been designed in accordance with best practice and includes mitigation and operational measures. However, there remains the possibility of structure accident and disaster events, particularly tunnel events. The three components – source, pathway, and receptor remain. It is not possible to eliminate the source (vehicular traffic) and receptors (human beings and natural environment). The pathway is restricted, though not eliminated through the implementation of fire suppression systems, vehicle restraint systems, adequate access for emergency services and holding tanks for tunnel runoff). Such systems will reduce the consequences and likelihood of major accidents and/or disasters; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to structure related events. This is the case as the loss of life or permanent injury cannot be categorically discounted.

It is therefore not possible to rule out low likelihood but potentially high consequence of a structure collapse or fire event and the vulnerability of the proposed road development to such events. Therefore, structure collapse and tunnel events are further assessed in **Table 19.1** in **Section 19.2.5**.

19.2.4.5 Services

Hazards identified relate to those associated with undertaking works on utilities (electrocution, gas explosion, burst watermain). Extensive consultation took place with utility service providers to ensure that a resilient and safe design was developed (appropriate protection measures and appropriate design criteria).

This interaction resulted in the incorporation of design measures to reduce or eliminate the consequences of potential risk events. The following measures are incorporated into the design to minimise or eliminate the consequences and likelihood of major accident and/or disaster events:

- all service diversions have been agreed with utility service providers. All service diversions must be undertaken in accordance with utility service providers requirements, all of which place health and safety to the fore
- safe construction, and the preparation of method statements, will be the responsibility of the Contractor. As noted previously, at the forefront of design development was the need to ensure that the proposed road development is capable of being constructed safely and without risk to health, can be maintained safely, and complies with all relevant health and safety legislation

Notwithstanding the fact that the utility diversions have been designed in accordance, and will be undertaken by or on behalf of the Contractor in line, with utility service provider requirements, there remains the possibility of additional diversions. Despite the extensive consultation there may still be some unknown services. The survey and information received from utility service providers covered the extent of the proposed road development, however, anomalies exist between these and interpretation is required. Further, even if a comprehensive map of all ground based infrastructure, and indeed overhead infrastructure, could be obtained, there is no guarantee that such conditions remain static, particularly so in the urban environment.

Thus, the three components - source, pathway, and receptor will remain. It is not possible to eliminate all sources (electric cabling, gas mains) and receptors (human beings, environmental receptors). The pathway is restricted but not eliminated, mitigation measures such as extensive consultation with providers and undertaking utility surveys have been undertaken but the pathway remains. Such mitigation will reduce the likelihood of major accidents and/or disaster events; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to utility service events. This is the case as the loss of life or permanent injury cannot be categorically discounted.

It is therefore not possible to rule out low likelihood but potentially high consequence utility service events (electrocution or gas explosion) and the vulnerability of the proposed road development to such events. Therefore, utility service events are further assessed in **Table 19.1** in **Section 19.2.5**.

19.2.4.6 Ground Conditions

The geotechnical design of the proposed road development has been undertaken in accordance with the national design standards (for example TII Publications), the Eurocodes, and best practice. This ensures a resilient and safe design. Ground investigations were undertaken which provided design criteria upon which to base the design of earthworks and foundations. Design criteria were utilised which reduce the consequences and likelihood of major accidents and/or disaster events associated with soils and geology by ensuring that a resilient design is prepared (safety factors etc.).

The ground investigations undertaken identified hazards such as poor ground conditions and karstic conditions. The results of these investigation were utilised in the design of the proposed road development to ensure that a resilient design was developed and to reduce the consequences and likelihood of events (bridge collapse due to inadequate foundations/bearing capacity, earthworks collapse due to utilisation of inadequate design criteria, earthworks collapse due to inadequate information of ground conditions).

Additionally, determining geotechnical design criteria required significant interaction with the various environmental specialists. This interaction resulted in the incorporation of design measures to reduce or eliminate the consequences of potential risk events. The following measures are incorporated into the design to minimise or eliminate the consequences and likelihood of major accident and/or disaster events:

- in flood prone areas a drainage layer is included to ensure hydraulic conductivity thus preventing water build-up which may result in or exacerbate flooding
- granular fill is proposed for embankments to ensure that sediment does not enter sensitive watercourses or groundwater bodies and impact environmental receptors (groundwater or watercourse pollution). In particularly sensitive areas the use of a geotextile separator is proposed
- in environmentally sensitive areas appropriate protection systems are included to avoid damage to environmental receptors (such as protection layer over Limestone pavement, rock fall ditches, flood bunding)
- with respect to the construction of Lackagh Tunnel, a construction methodology has been proposed which places safety to the fore so as to eliminate the risk of tunnel collapse. The development of this methodology has been influenced by geotechnical investigation which determined appropriate design criteria. Refer to **Chapter 9, Soils and Geology** and **Appendix A.7.3** for further information
- blasting operations during construction will be subject to re-calibration based on site specific conditions and will only be undertaken by appropriately qualified persons (minimises risks associated with blast rock)

In addition to design measures, horizontal movement and vibration monitoring (rock mass monitoring, karst ground areas) will be implemented to ensure that movements will not result in hazards which could cause major accident and/or disaster events, during the construction or operation of the proposed road development. This is essential as hazard events often arise from natural events (heavy rainfall etc.) and the only feasible means of mitigating the impacts of such events is to ensure a resilient design is prepared, as detailed above, and that appropriate control measures (monitoring, response times) are implemented during both the construction and operation of the proposed road development.

The geotechnical design for the proposed road development has been designed in accordance with best practice and includes design measures and mitigation measures as noted. There still remains however, the possibility of geotechnical events. Despite the ground investigations and assessment complete unknown ground conditions remain as the investigations undertaken were targeted to areas of interest and the results had to be interpolated for the areas in-between. It is not possible to map all ground based hazards. Further, even if all ground based hazards could be identified at this point, there is no guarantee that such conditions will remain constant given the karstic nature of the ground.

The three components - source, pathway, and receptor will remain. It is not possible to eliminate all sources (karstic conditions, weather events) and receptors (human beings, environmental receptors). The pathway is restricted, though not eliminated through design and mitigation measures. Such measures will temper the likelihood of major accidents and/or disasters; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to ground condition events. This is the case as the loss of life or permanent injury cannot be categorically discounted (engulfment due to earthworks collapse or events triggered by ground related events).

It is therefore not possible to rule out low likelihood but potentially high consequence of ground collapse events and the vulnerability of the proposed road development to such events. Therefore, ground collapse events are further assessed in **Table 19.1** in **Section 19.2.5**.

19.2.4.7 Hydrogeology

Potential hydrogeological impacts of the proposed road development were evaluated in accordance with TII DN-DNG-03065 (Road Drainage and the Water Environment). This standard reflects the requirements of the following:

- The EU Water Framework Directive (WFD) 2000/60/EC
- The Groundwater Directive 2006/118/EC
- European Communities Environmental Objectives (Groundwater) Regulations 2010
- European Communities Environmental Objectives (Surface Water) Regulations 2009
- European Communities (Drinking Water) (No.2) Regulations 2007
- European Communities (Quality of Salmonid Waters) Regulations 1988
- Water Services Acts 2007 – 2013

The hydrogeological investigations undertaken identified groundwater levels and groundwater movement. The results of these investigation were utilised in the design of the proposed road development to ensure that a resilient design was developed and to reduce the consequences and likelihood of events (groundwater contamination of an aquifer due to inadequate information, groundwater inundation to tunnels or onto road surface due to inaccurate design criteria).

Additionally, determining design criteria with respect to hydrogeology required significant interaction with the various environmental specialists. This interaction resulted in the incorporation of design measures to reduce or eliminate the consequences of potential risk events (pollution to groundwater bodies or aquifers, groundwater flooding). The following measures are incorporated into the design to minimise or eliminate the consequences and likelihood of major accident and/or disaster events:

- A risk assessment in accordance with TII DN-DNG-03065 was undertaken (groundwater vulnerability and aquifer classification). This assessment was supplemented by site specific hydrogeological risk assessments. This standard and the associated assessment takes into account climate change requirements (appropriate protection measures to prevent groundwater contamination as a result of the proposed road development was determined and included in the design)

- Based on the spillage risk assessment (refer to **Chapter 10, Hydrogeology**) the risk of a serious spillage occurring has an annual probability of less than 0.5% and is considered acceptable per TII DN-DNG-03065. Notwithstanding the low risk of serious spillage, additional spillage protection measures are included at each drainage outfall location, these spillage containment areas prevent the contamination of groundwater and surface water bodies by providing 25m^3 of containment for accidental spillages of hydrocarbons and chemicals per DN-DNG-03022 (Drainage Systems for National Roads). During a spillage event, the spill will be collected by the drainage network and conveyed towards the outfall where a penstock will divert the spill to the spillage containment area where it will be contained until it can be safely removed and disposed
- Hydrogeological information has been utilised to determine design requirements, for example, hydrogeological assessment information has been utilised to determine waterproofing and groundwater inundation levels for the proposed Lackagh Tunnel and Galway Racecourse Tunnel thereby reducing the potential for the proposed road development to flood during operation and result in major accidents and/or disasters
- The proposed road development has been designed considering the hydrogeological assessment information to determine design elevations thereby reducing the potential for the proposed road development to flood during operation and result in major accidents and/or disasters. Similarly, a drainage layer has been included in the design at appropriate locations to ensure hydraulic conductivity is maintained
- The results of the hydrogeological assessment have been used to determine tunnel waterproofing requirements thereby reducing the potential for the proposed road development to flood during operation and result in major accidents and/or disasters

The hydrogeological design of the proposed road development has been designed in accordance with best practice and includes design measures and mitigation measures but as noted, there remains the possibility of hydrogeological accident and disaster events. Despite the extensive investigations and assessment, unknown ground conditions remain as the investigations undertaken were targeted to areas of interest and the results had to be interpolated for the areas in-between. Further, even if all ground based hazards could be identified, there is no guarantee that such conditions remain constant, given the karstic nature of the ground.

The three components - source, pathway, and receptor remain. It is not possible to eliminate all sources (karstic conditions or weather events) and receptors (human beings and environmental receptors) and the pathway is restricted, though not eliminated through design measures and mitigation. Such measures will reduce the likelihood of major accidents and/or disaster events; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to hydrogeology events (groundwater contamination or groundwater inundation). This is the case as the loss of life or permanent injury cannot be categorically discounted (drowning due to groundwater inundation or harm consequent to groundwater contamination).

It is therefore not possible to rule out low likelihood but potentially high consequence hydrogeological events (flooding or groundwater contamination) and the vulnerability of the proposed road development to such events. Therefore, hydrogeological events are further assessed in **Table 19.1** in **Section 19.2.5**.

19.2.4.8 Hydrology

The drainage design for the proposed road development was undertaken in accordance with TII DN-DNG-03065 (Road Drainage and the Water Environment).

Based on the spillage risk assessment (refer to **Chapter 11, Hydrology**) the risk of a serious spillage occurring has an annual probability of less than 0.5% and is considered acceptable per TII DN-DNG-03065. Notwithstanding the low risk of serious spillage, additional spillage protection measures are included at each drainage outfall location, these spillage containment areas prevent the contamination of groundwater bodies or surface water by providing 25m^3 of containment for accidental spillages of hydrocarbons and chemicals per DN-DNG-03022 (Drainage Systems for National Roads). During a spillage event, the spill will be collected by the drainage network and conveyed towards the outfall where a penstock will divert the spill to the spillage containment area where it will be contained until it can be safely removed and disposed.

As per this standard and the European Union: Directive on the Assessment and Management of Flood Risks (2007/60/EC) a Flood Risk Assessment (FRA) was undertaken for the proposed road development. The proposed road development is essential infrastructure and is therefore considered to be ‘highly vulnerable development’ according to the Flood Risk Management Plan Guidelines. The FRA considered fluvial, pluvial, and groundwater flooding. Both the FRA and TII DN-DNG-03065 standard take into account climate change requirements.

The results of the FRA were utilised to determine design criteria to reduce the likelihood of major accidents and/or disaster events associated with flooding by ensuring that a resilient design was prepared (waterproofing and freeboard above maximum water level). The results of the FRA were utilised in the design of the proposed road development to ensure that a resilient design was developed and to reduce the likelihood of events (flood inundation to tunnels or onto road due to inadequate design criteria or flooding to assets adjacent to the proposed road development).

The FRA resulted in the incorporation of design measures to reduce or eliminate the consequences of potential events (flooding). Without appropriate flood relief design the proposed road development would have the potential to significantly impact on drainage in its vicinity and exacerbate flood risk. The following measures are incorporated into the design to minimise or eliminate the consequences and likelihood of major accidents and/or disaster events:

- mitigation measures to neutralise the flood impact to the Twomileditch – ‘Significant Pluvial Flood Risk’. With the mitigation in place the loss of flood storage is compensated and there is a moderate to significant positive impact on flooding and flood risk in the Twomileditch and N83 Tuam Road area

- the potential flood risk for the Lackagh Tunnel and Galway Racecourse Tunnel is rated as representing a moderate flood risk. This risk is associated with the potential for elevated groundwater table under more extreme 1000-year flood events and climate change conditions. The tunnels are to be fully sealed and groundwater ingress will be prevented
- the proposed tunnels, by virtue that waters require pumping to the foul sewer, retain a residual flood risk e.g. pump failure. This residual risk is mitigated through proposed regular inspection and maintenance procedures
- road drainage outfalls discharging to receiving surface and groundwaters without flood flow attenuation, could increase downstream and cause local flooding at the discharge points. This has been mitigated in the drainage design through suitably sized attenuation ponds and outlet flow controls
- potential blockages to culverts and bridges on streams and the lack of maintenance could present a localised residual flood risk. This residual risk is mitigated through proposed regular inspection and maintenance procedures
- residual risk of localised flooding on the proposed road carriageway due to blockages/failure within drainage network. This residual risk is mitigated through proposed regular inspection and maintenance procedures
- this residual flood risk can be managed through a program of regular inspection and maintenance of drainage facilities that includes, gullies, inspection chambers, pipes, culverts, outfalls, attenuation ponds and infiltration basins

The drainage design of the proposed road development has been completed in accordance with best practice and includes design measures and mitigation measures as noted above. However, there remains the possibility of hydrological (flooding or water pollution) events.

The three components - source, pathway, and receptor will remain. It is not possible to eliminate all sources (karstic conditions or weather events) and receptors (human beings and environmental receptors). The pathway is restricted, though not eliminated through design measures and mitigation measures. Such measures will reduce the likelihood of major accidents and/or disaster events; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to hydrology events (pump failure, interaction with hydrogeology). This is the case as the loss of life or permanent injury cannot be categorically discounted.

It is therefore not possible to rule out low likelihood but potentially high consequence hydrological events (flooding or water contamination) and the vulnerability of the proposed road development to such events. Therefore, hydrological events are further assessed in **Table 19.1**.

19.2.5 Risk Screening Summary

When undertaking this screening process, a number of low likelihood but potentially high consequence events were identified for a number of disciplines. These events are applicable to both the construction and operational phases of the proposed road development.

The events requiring further assessment are:

- Vehicular Events
- Structural Collapse Events
- Tunnel Fire Events
- Service Utilities Events
- Ground Conditions Related Events
- Hydrogeological Events
- Hydrological Events

The assessment of these events is detailed in **Table 19.1**.

19.2.6 Major Accidents and/or Disasters Assessment

The assessment of the risk of major accidents and/or disasters that were not screened out is presented in this section.

Table 19.1 presents hazards which remained following the screening process, defines the impact (the reasonable worst consequence if the hazard occurred), assesses the likelihood of the hazard occurring, and assesses the consequent risk. As part of this assessment embedded mitigation which reduces the hazard, the likelihood of the hazard, and significance of the potential risk consequent to the hazard is detailed. Ultimately it will be determined whether the risk could constitute a major accident and/or disaster and, if so, whether the risk has been mitigated to the greatest degree possible.

Table 19.1: Environmental Risk Record

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
Vehicular Events				
Vehicular accident event resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts.	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Vehicular accident events cannot be discounted. Such events are likely to occur during the operation of the proposed road development. This assessment examines the implications of low likelihood but potentially high consequence vehicular accident events (multi-vehicle collision resulting in a large number of fatalities). Damage to an environmental receptor may occur. Such damage can occur via discharge of hazardous (e.g. hydrocarbon oils, corrosive or toxic liquids) materials to the existing environment. In this case the risk is that of impacting groundwater or surface water, which may result in impacts on humans or ecological receptors. If a vehicular accident event occurs it may result in events external to	The proposed road development has been designed in accordance with best practice and national standards ensuring that the proposed road development is designed safely and will thus operate safely. Vehicular restraint systems have been incorporated into the design of the proposed road development to reduce the severity and potential consequences of vehicular accident events, where they may occur. Access points have been provided that will enable efficient access for emergency services and make their response times more efficient and reduce the severity and potential consequences of vehicular accident events, where they may occur i.e. incidents will not be exacerbated by delayed response or the inability to access an event location.	Emergency service organisations, local authority personnel, and regional authority personnel are responsible for responding to and coordinating the response to the fallout of major accidents and/or disasters, including vehicular accident events. In this regard a Major Emergency Plan is prepared and operated by these organisations. As part of the design process for the proposed road development representatives of these organisations were consulted and measures were incorporated into the design to enhance response to the fallout of major accidents and/or disasters, including vehicular accident events.

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
		the proposed road development, such as fire events. Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	Intelligent transport systems have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure). The drainage system has been designed to contain fuel / oil spills using spillage containment areas, penstocks and hydrocarbon interceptors. Spills will not discharge into the receiving environment in the event of a major spillage event as the pathway can be blocked with the implementation of the above measures. .	All reasonably practical measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence vehicular accident events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential consequences of vehicular accident events. The road authority will be responsible for responding to and coordinating the response to events on the network (environmental clean-up of oil spills, managing traffic flows etc.) and maintenance (removing hazards which may result in risk events, fixing vehicular restraint systems). With regard to implementation

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
				of the schedule of environmental commitments and response to environmental incidents an Environmental Operating Plan for the operational phase is prepared and operated by the Road Authority based on the CEMP in **Appendix A.7.5**. No additional mitigation measures are required.
Structural Collapse Events				
Structural collapse (bridge collapse, tunnel collapse) event resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that cannot be	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Structural collapse events are extremely rare but their potential consequences are significant. They cannot be discounted as collapse may occur due to events outside the control of the designer, contractor, or road authority, for example, act of terrorism, other third party interference, or other unusual circumstances. Impacts on an environmental receptor may occur. Such impacts include surface or groundwater quality (collapse into	Structures have been designed taking account of the potential for vehicle strike incidents. The severity and potential consequence of strike events has been reduced via the introduction of vehicular restraint systems. All structure foundations have been designed taking cognisance of anticipated ground conditions, appropriate foundations have been proposed taking cognisance of same and thus reducing likelihood of structural collapse events due to ground conditions.	Structural collapse due to negligent inspection/ maintenance has been discounted as the road authority in Ireland undertake inspections on all structural assets on a regular basis. The road authority will be responsible for responding to and coordinating the response to events on the network (environmental clean-up - oil spills, managing traffic flows etc.) and maintenance

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
restored through minor clean-up and restoration efforts.		watercourses); human beings, population and health; or biodiversity Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	Access points have been provided that will enable efficient access for emergency services and make their response times more efficient and reduce the severity and potential consequences of events, where they may occur i.e. incidents will not be exacerbated by delayed response or the inability to access an event location. Particular attention has been paid to the potential for collapse of drill and blast tunnels. Permanent tunnel stability at Lackagh Tunnel will be provided by a cast in-situ reinforced concrete lining. Fibre reinforced concrete or sacrificial cover, has been included in the design of tunnels to reduce the risk of spalling - a phenomenon whereby portions of concrete fall off the tunnel lining during a fire therefore reducing the overall performance of the structure due to reduced concrete depth (including sacrificial cover minimises the	(removing hazards which may result in risk events, fixing vehicular restraint systems). With regard to implementation of the schedule of environmental commitments and response to environmental incidents a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental Operating Plan for the operational phase and operated by the Road Authority. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence structural events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
			likelihood of collapse due to fire events). Intelligent transport systems have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure).	the severity and potential consequences of structural events. No additional mitigation measures are required.
Tunnel Fire Events				
Tunnel events (explosions, fire) resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Such tunnel events are extremely rare but their potential consequences are significant. Tunnel events are rare because extensive preventative and mitigatory systems are incorporated into tunnels to reduce the severity and potential consequences of tunnel events (fire, partial or total tunnel collapse vehicular accident event, spillage or fuel or other hazardous liquids). In addition to physical mitigation such as vehicle restraint systems, operational	Structures have been designed taking account of vehicular strike incidents and the severity and potential consequence of strike events has been reduced via the introduction of vehicular restraint systems. The proposed road development has been designed in accordance with best practice and European standards ensuring that the proposed road development is designed safely and will thus operate safely. Access points have been provided that will enable efficient access for	Emergency service organisations, local authority personnel, and regional authority personnel are responsible for responding to and coordinating the response to the fallout of major accidents and/or disasters, including vehicular accident events. In this regard a Major Emergency Plan is prepared and operated by these organisations. As part of the development of the proposed

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
and restoration efforts.		measures have been incorporated into the design which will act to mitigate the potential consequences of vehicle accident events such as a vehicle fire events within the tunnel. Low likelihood but potentially high consequence tunnel events cannot be discounted as events may occur due to events outside the control of the designer, contractor, or road authority. For example, act of terrorism, other third party interference, or other unusual circumstances. Tunnel events require particular regard due to their confined nature (any event may escalate quickly). Damage to an environmental receptor may occur. Such damage can occur via discharge of materials to the existing environment (fuel, oil, gas). In this case the risk is that of impacting groundwater or surface water, which may result in impacts to human beings, or ecological receptors	emergency services and make their response times more efficient and reduce the severity and potential consequences of events, where they may occur i.e. any incidents will not be exacerbated by delayed response or the inability to access an event location. Tunnels are naturally ventilated reducing the potential for smoke/gas accumulation. Intelligent transport systems have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure). The drainage system has been designed to retain fuel/oil spills and not discharge this to the receiving environment (blocking pathway) and thus impact an environmental receptor.	road development representatives of these organisations were consulted and design measures were incorporated into the design to enhance response to the fallout of major accidents and/or disasters, including tunnel events. The Road Authority will be responsible for responding to and coordinating the response to events on the network (environmental clean-up - oil spills, managing traffic flows etc.) and maintenance (removing hazards which may result in risk events, fixing vehicular restraint systems). With regard to implementation of the schedule of environmental commitments and response to environmental incidents a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
		Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	Systems have been included in the design of the tunnels to reduce the severity and potential consequences of tunnel events (fire, vehicular accident event). Cross passages are incorporated into both tunnels enabling persons to rapidly exit the tunnel and allowing emergency service personnel and the road authority to access incidents.	Operating Plan for the operational phase and operated by the Road Authority. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence tunnel events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential consequences of tunnel events. No additional mitigation measures are required.

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
Service Utility Events				
Service events (explosions from gas mains, flooding from burst watermains, fire from striking electric cabling, electrocution from striking electric cabling, fire) resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts.	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	This assessment examines the implications of low likelihood but potentially high consequence service events (electrocution, gas explosion, burst watermain). Damage to an environmental receptor may occur. Such damage can occur via discharge of materials to the existing environment (e.g. gas from the existing gas network). In this case the risk is that of impacting groundwater or surface water, which may result in impacts to humans or ecological receptors. Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	All service diversions have been agreed with utility service providers. All service diversions must be undertaken in accordance with utility service providers' requirements, all of which place health and safety to the fore. Safe construction, and the preparation of method statements, will be the responsibility of the Contractor. As noted previously, at the forefront of design development was the need to ensure that the proposed road development is capable of being constructed safely and without risk to health, can be maintained safely, and complies with all relevant health and safety legislation.	Service events risk can be managed through implementation of a safe system of work. The road operator will be responsible for responding to and coordinating the response to events on the network (environmental clean-up - oil spills, managing traffic flows etc.) and maintenance (removing hazards which may result in risk events, fixing vehicular restraint systems). With regard to implementation of the schedule of environmental commitments and response to environmental incidents, a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental Operating Plan for the operational phase and

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
				operated by the Road Authority. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence service events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential consequences of service events. No additional mitigation measures are required

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
Ground Conditions Related Events				
Ground related events (ground collapse) resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts.	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Ground related collapse events are extremely rare but their potential consequences are significant. They cannot be discounted as collapse may occur due to events outside the control of the designer, contractor, or road authority. For example, natural phenomena, natural events - extreme rainfall. Damage to an environmental receptor may occur. Such damage can occur via collapse of an element of the proposed road development resulting in damage to the ancillary operational elements of the proposed road development, for example the drainage system which may result in discharge of materials to the existing environment (fuel, oil, gas, hazardous liquids). In this case the risk is that of impacting groundwater or surface water, which may result in impacts to humans or ecological receptors.	The proposed road development has been designed in accordance with best practice and national standards ensuring that the proposed road development is designed safely and will thus operate safely. Access points have been provided that will enable efficient access for emergency services and the road operator and make their response times more efficient and reduce the severity and potential consequences of events, where they may occur i.e. any incidents will not be exacerbated by delayed response or the inability to access an event location. Embankments/cuttings have been designed taking cognisance of anticipated ground conditions, appropriate foundations have been proposed taking cognisance of same and thus reducing likelihood of structural collapse events due to ground conditions.	Structural collapse due to negligent inspection / maintenance has been discounted as the Road Authority in Ireland undertake inspections on all assets. The road operator will be responsible for responding to and coordinating the response to events on the network, including service events (environmental clean-up, fixing vehicular restraint systems etc). In this regard a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental Operating Plan for the operational phase and operated by the Road Authority. All reasonable practicable measures have been included in the design of the proposed road development to reduce

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
		Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	Drill and blast tunnels are of particular interest when it comes to ground related events. Permanent tunnel stability at Lackagh Tunnel will be provided by a cast in-situ reinforced concrete lining. Intelligent transport systems have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure).	the severity and potential consequences of low likelihood but potentially high consequence ground related events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential consequences of ground related events. No additional mitigation measures are required.
Hydrogeological Events				
Hydrogeological events (flooding, groundwater contamination) resulting in loss of life or permanent injury or permanent or long-lasting	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Hydrogeological events are extremely rare but their potential consequences are significant. They cannot be discounted, hydrogeological events may be consequent to other events (structure collapse, vehicular accident event, hydrological event) or may be outside the control of the designer, contractor, or road	The proposed road development has been designed in accordance with best practice and national standards ensuring that the proposed road development is designed safely and will thus operate safely. The drainage system has been designed to contain fuel/oil spills using spillage containment areas, penstocks and hydrocarbon	Groundwater risk can be managed through a program of regular inspection and maintenance.The road operator will be responsible for responding to and coordinating the response to events on the network (environmental clean-up - oil spills, managing traffic flows

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts.		authority. For example, natural phenomena, natural events - extreme rainfall, extreme groundwater levels. Damage to an environmental receptor may occur. In this case the risk is that of impacting groundwater or surface water, which may result in impacts to humans or environmental receptors. Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	interceptors. Spills will not discharge into the receiving environment in the event of a major spillage event as the pathway can be blocked with the implementation of the above measures. Access points have been provided that will enable efficient access for emergency services and make their response times more efficient and reduce the severity and potential consequences of events, where they may occur i.e. any incidents will not be exacerbated by delayed response or the inability to access an event location. Systems have been included in the design of the tunnels to reduce the severity and potential consequences of tunnel events (pump systems etc.). Cross passages are incorporated into both tunnels enabling persons to rapidly exit the tunnel and allowing emergency service personnel and the road operator to access incidents. Tunnels require particular attention when it comes to groundwater interactions. Permanent	etc.) and maintenance (removing hazards which may result in risk events, fixing vehicular restraint systems). With regard to implementation of the schedule of environmental commitments and response to environmental incidents a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental Operating Plan for the operational phase and operated by the Road Authority. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence hydrogeological related events. Appropriate precautionary measures have been included in the design of

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
			waterproofing of the tunnels will be provided by the application of a water proof membrane/barrier. Intelligent transport systems have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure).	the proposed road development to reduce the severity and potential consequences of hydrogeological related events. No additional mitigation measures are required.
Hydrological Events				
Hydrological events (flooding, groundwater, surface water contamination) resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Hydrological events are extremely rare but their potential consequences are significant. They cannot be discounted, hydrological events may be a result from other events (structure collapse, vehicular accident event, hydrological event, hydrogeological event) or may be outside the control of the designer, contractor, or road authority. For example, natural phenomena, natural events - extreme rainfall, extreme groundwater levels.	The proposed road development has been designed in accordance with best practice and national standards ensuring that the proposed road development is designed safely and will thus operate safely. The drainage system has been designed to retain fuel/oil spills and not discharge this to the receiving environment (blocking pathway) and thus impact an environmental receptor. Access points have been provided that will enable efficient access for	Flood risk can be managed through a program of regular inspection and maintenance of drainage facilities. The road operator will be responsible for responding to and coordinating the response to events on the network (environmental clean-up - oil spills, managing traffic flows etc.) and maintenance (removing hazards which may result in risk events, fixing vehicular restraint systems).

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
cannot be restored through minor clean-up and restoration efforts.		Damage to an environmental receptor may occur. In this case the risk is that of impacting groundwater or surface water, which may result in impacts to humans or ecological receptors. Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	emergency services and make their response times more efficient and reduce the severity and potential consequences of events, where they may occur i.e. any incidents will not be exacerbated by delayed response or the inability to access an event location. Systems have been included in the design of the tunnels to reduce the severity and potential consequences of tunnel events (pump systems etc.). Cross passages are incorporated into both tunnels enabling persons to rapidly exit the tunnel and allowing emergency service personnel and the road operator to access a flooding incident. Tunnels require particular attention when it comes to flooding. Permanent waterproofing of the tunnels will be provided by the application of a water proof membrane/barrier. Intelligent transport systems have been incorporated into the design which will act to mitigate the	With regard to implementation of the schedule of environmental commitments and response to environmental incidents a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental Operating Plan for the operational phase and operated by the Road Authority. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence hydrological related events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
			potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure).	consequences of hydrological related events. No additional mitigation measures are required.

19.2.7 Mitigation Measures

Following the assessment of the proposed road development, under the heading of vulnerability to major accidents and/or disasters, it is concluded that no further mitigation measures beyond those already incorporated and described above and elsewhere in this EIAR are required.

19.2.8 Residual Impacts

The potential for low likelihood but potentially high consequence major accident and/or disaster events remains, although the possibility is extremely unlikely. These events have been considered throughout the design process and measures have been included in the design to reduce the severity and potential consequences of such events.

19.2.9 Summary

This section presented an assessment of the likely significant adverse effects of on the environment arising from the vulnerability of the proposed road development to risks of major accidents and/or natural disasters. The risk assessment identified and quantified risks due to the proposed road development focusing on: unplanned, but possible and plausible events occurring during the construction and operational phases. From examining all plausible risks associated with the proposed road development, the scenarios which are considered to be the highest risk in terms of a major accident and/or disaster included:

- vehicular events
- structural collapse events
- tunnel fire events
- service utilities events
- ground conditions related events
- water related events

The outcome of the assessment identified that while these events would have ‘very serious’ consequences should they occur; the risk is considered ‘unlikely.’ These events have been considered throughout the design process and measures have been included in the design to reduce the severity and potential consequences of such events.

19.3 Methodology used to assess interactions and cumulative impacts

19.3.1 Guidance

As described previously in **Section 19.1**, the requirement to address interactions of effects and cumulative impacts is set out in the EIA Directive as amended by Directive 2014/52/EU on the assessment of the effects of certain public and private projects on the environment and in the Roads Act 1993, as amended.

This chapter has been prepared in accordance with the following guidance:

- EPA (2017) Guidelines on the Information to be contained in Environmental Impact Assessment Reports, Draft, August 2017
- European Commission (2017) Environmental Impact Assessment of Projects – Guidance on the preparation of the Environmental Impact Assessment Report. (Office for Official Publications of the European Communities 2017)
- EPA (2015) Revised Guidelines on the Information to be contained in Environmental Impact Statements, Draft, 2015
- EPA (2015) Advice Notes on Current Practice in the Preparation of Environmental Impact Statements, Draft, 2015
- EPA (2003) Advice Notes on Current Practice in the Preparation of Environmental Impact Statements, 2003
- EPA (2002) Guidelines on the Information to be contained in Environmental Impact Statements, 2002
- European Commission (1999) Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions, (Office for Official Publications of the European Communities 1999)

19.3.2 Assessment Methodology

At the initial stage of preparing the EIAR for the proposed road development, the potential for significant interactions of impacts and cumulative impacts were examined and any potential impacts were identified. These potential impacts were included in the scope and addressed in the baseline and impact assessment studies for each of the relevant environmental factors and were also addressed in the design of the proposed road development.

There were numerous discussions and communications including workshops and meetings between the environmental specialists and the design team throughout the design process which helped to identify and minimise the potential for significant interactions of impacts and cumulative impacts arising in the first instance.

The interaction of impacts within the design of the proposed road development and the mitigation measures relative to those interactions in respect of each of the environmental factors have been identified and addressed in detail in the respective chapters dealing with each environmental factor in this EIAR. Thus no additional mitigation is proposed in this chapter. This chapter presents a summary of each assessment of the interaction (inter-relationship) of impacts (from the proposed road development) between the various environmental factors and summarises the mitigation measures relative to those interactions.

The matrix and expert opinion approaches, as outlined in the EU Guidelines (1999), were used in the identification of the potential for significant interactions of impacts. Refer to **Tables 19.2** for the matrix of potential interactions.

Similarly, cumulative impacts arising from the interaction between the proposed road development and other projects in respect of each of the environmental factors have been identified and addressed in detail in the respective chapters dealing with each environmental factor in this EIAR. This chapter however, presents a summary of these individual cumulative assessments with other projects and considers the cumulative effect of the entirety of the project as a whole with other projects. No additional mitigation measures are proposed in this chapter.

19.3.3 Definitions

The following definitions are generally used in the description of cumulative impacts or interaction of impacts.

Cumulative effects are defined in EC guidance (2017)[12] as: "*Changes to the environment that are caused by activities/projects in combination with other activities/projects*". EC guidance (2017) also states that "*it is important to consider effects not in isolation, but together, that is cumulatively". Cumulative effects are changes to the environment that are caused by an action in combination with other actions. They can arise from*

- *The interaction between all of the different projects in the same area*
- *The interaction between various impacts within a single project"*

Cumulative effects are also defined in EPA guidance (2017)[13] as "*The addition of many minor or significant effects, including effects of other projects, to create larger, more significant effects*".

The EU guidelines (1999)[14] use slightly different definitions as follows:

Cumulative Impacts: Impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project.

Impact Interactions: The reactions between impacts whether between the impacts of just one project or between the impacts of other projects in the area.

The term '*impact interactions'* is equivalent to the term '*inter-relationship of* effects'. The EU guidelines (1999) accept that their definitions overlap to a certain

[12] European Commission (2017) Environmental Impact Assessment of Projects – Guidance on the preparation of the Environmental Impact Assessment Report
[13] Environmental Protection Agency (2017) Guidelines on the Information to be contained in Environmental Impact Assessment Reports. Draft, August 2017
[14] European Commission (1999) Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions

extent. The EU guidelines also refer to '*Cross-Media Impacts'*, in which the impact in one environmental medium may also have an indirect impact on another medium.

19.4 Interaction of Impacts

19.4.1 Matrix of Impacts

All environmental factors are inter-related to some extent, and the relationships can range from tenuous to inextricable. The interactions between the identified environmental impacts have already been considered and assessed within the individual chapters of this EIAR. There have been numerous discussions and communications including workshops and meetings between the environmental specialists and the design team throughout the design process which helped to identify and minimise the potential for significant interaction of impacts. Measures to minimise impacts have been incorporated into the design and are also included in all of the assessments and the residual impacts have been assessed.

For example, where it has been established in **Chapter 11, Hydrology** that there will be an increase in suspended solids or pollutants during construction arising from earthworks, then **Chapter 8, Biodiversity** has assessed the effect of that on aquatic flora and fauna. Measures to minimise impacts of suspended solids or pollutants have been designed with consideration to those interactions and have been incorporated into both the hydrology and biodiversity chapters and the residual impacts on both hydrology and biodiversity have been assessed. Similarly, where **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration** have established that there will be air and noise emissions during both the construction and operational phases, **Chapter 18, Human Beings, Population and Human Health** has assessed the effect of those emissions on human health and **Chapter 8, Biodiversity** has assessed the effects of those emissions on sensitive flora and fauna. Measures to minimise the air and noise emission impacts have been designed with consideration to those interactions and have been included in the assessments and the residual impacts have been identified.

Table 19.2 presents the potential interactions between the environmental factors in a matrix format. It examines the potential for the environmental factor or issue in the left hand column to have an impact on the environmental factor listed in the top row of the matrix as a result of the proposed road development. As discussed above, these potential interactions of impacts were identified throughout the design process and measures addressing these impacts have already been included within the individual chapters of this EIAR. The paragraphs following **Table 19.2** present an assessment of the potential interactions of impacts, mitigation measures and residual impacts. This assessment is based on information contained within this EIAR and the outcome of discussions and interactions between the environmental specialists and the design team.

If there is the potential for an impact during the construction phase, this is indicated by a 'C'. An 'O' indicates the potential for an impact during the operational phase and 'CO' indicates the potential for an impact during both phases. If it is considered that there will be no potential for an impact, this is indicated by 'none'.

For example, the construction of the proposed road development will require construction traffic movements (left hand column) which could potentially generate negative impacts ("C") on a number of environmental factors (top row of table) such as air quality and climate, noise and vibration, biodiversity, human beings, population and human health, material assets (both agriculture and non-agriculture) and the risk of major accidents and/or natural disasters. These environmental factors could then in turn result in (secondary/indirect) impacts on other environmental factors. For example, excavation activities will generate material (direct impact on soil and rock resource) some of which will require transportation (secondary impact on construction traffic) and disposal (secondary impact on resource capacity offsite). Air emissions (secondary impact) arising from this construction traffic could subsequently impact on human beings, population and human health. All of these interactions and secondary/indirect impacts have been considered in each of the respective chapters of this EIAR.

Table 19.2: Potential Interaction of Impacts Matrix (C = Construction, O = Operational, 'None = no potential impact)

Key environmental Interaction Matrix	**Traffic**	**Air Quality and Climate**	**Noise and Vibration**	**Biodiversity**	**Archaeological, Architectural and Cultural Heritage**	**Landscape and Visual**	**Soil and Water**	**Resource and Waste Management**	**Material Assets Non-Agriculture**	**Material Assets Agriculture**	**Human Beings, Population and Human Health**	**Risk of Major Accident and/or Disaster**
Traffic		CO	CO	CO	None	None	CO	C	CO	CO	CO	CO
Air Quality and Climate Factors	None		None	CO	None	None	None	None	C	C	CO	None
Noise and Vibration	None	None		C	None	None	C	None	C	C	CO	None
Biodiversity	None	None	None		None	CO	None	None	None	None	C	None
Archaeological, Architectural and Cultural Heritage	None	None	None	C		CO	None	None	None	None	C	None
Landscape and Visual	CO	None	O	CO	CO		None	None	CO	CO	CO	None
Soil and Water	C	C	C	CO	None	C		C	C	C	C	None
Resource and Waste Management	C	None	None	None	None	None	None		None	C	C	None
Material Assets Non Agriculture	CO	None	None	None	None	CO	None	C		None	CO	None
Material Assets Agriculture	None	None	None	None	None	None	None	C	None		CO	None
Human Beings, Population and Human Health	CO	None	None	None	C	None	None	C	CO	None		None
Risk of major accident and/or disaster	CO	CO	CO	CO	None	None	CO	None	CO	None	CO	

19.4.2 Potential Interactions

All of the potential impacts arising from the potential interactions were identified at a very early stage in the design process and in the EIAR preparation. They were therefore addressed in the design of the proposed road development and in the environmental baseline and impact assessment studies. As a result, the potential impacts were either avoided altogether through design measures or they were addressed through specific mitigation measures. This early identification process helped to identify and minimise the potential for significant interactions of impacts arising. The potential impacts and mitigation measures are discussed further below.

19.4.2.1 Overview of Traffic Interactions

Construction Phase

The construction of the proposed road development will require construction traffic movements which could potentially generate negative impacts on a number of environmental factors such as air quality and climate, noise and vibration, biodiversity, human beings, population and human health, visual impact, material assets (both agriculture and non-agriculture) and the risk of major accidents and/or natural disasters.

The level of construction traffic generation is dependent on the types, intensity and duration of construction activities taking place. For example, if there are significant volumes of excavated material or demolition materials which require disposal offsite or if significant materials are required to be imported on site, these activities have the potential to generate significant construction traffic volumes.

Construction traffic movements have the potential to generate a visual impact as well as air quality and noise and vibration emissions which could potentially negatively impact on human beings, population and human health. The generation of construction traffic will also result in road diversions and general short term disruption for people and properties in the area which could potentially negatively impact on material assets. In addition, construction traffic has the potential to negatively impact on biodiversity arising from severance, disturbance and mortality. Finally, there is a potential interaction between construction traffic and the risk of major accidents and/or natural disasters arising from the risk of a major traffic accident occurring during the construction phase.

Operational Phase

Operational traffic and the physical presence of the proposed road development could potentially generate negative impacts on the same environmental factors identified for the construction phase above.

19.4.2.2 Interaction of Traffic with Air Quality and Climate

Construction Phase

An air quality assessment of construction traffic impacts was carried out and the results show that all of the predicted concentrations are in compliance with the air quality standards (Refer to **Table 16.20** of **Chapter 16, Air Quality and Climate**). Therefore, significant residual impacts from construction traffic on air quality and subsequently human beings, population and human health will not arise.

During the construction phase of the proposed road development, 150,000 tonnes per year of CO_2 are estimated to be generated (arising from all construction activity, not just construction traffic), assuming a 36-month construction programme. Ireland has committed to achieve a 20% reduction in non-Emission Trading Scheme (ETS) greenhouse gas emissions by 2020 (relative to 2005 levels). The emissions predicted to be produced during the construction phase of the proposed road development constitutes 0.39% of Ireland's 2020 CO_2 limit under the EU Climate Change and Renewable Energy Package. These emissions will occur for the duration of the construction phase. Measures to mitigate these potential impacts on climate are outlined in **Section 16.6** of **Chapter 16, Air Quality and Climate** and include measures such as the implementation of an energy management system and a Construction Traffic Management (CTMP) (as presented in the CEMP in **Appendix A.7.5**). The overall conclusion of the air quality and climate assessment is that with the implementation of such mitigation measures, no significant residual impacts on air quality climate will arise during the construction phase.

Operational Phase

An air quality assessment during the operational phase of the proposed road development was carried out and the results show that all of the predicted concentrations are in compliance with the air quality standards (Refer to **Table 16.20** of **Chapter 16, Air Quality and Climate**). Therefore, significant residual impacts from construction traffic on air quality and subsequently human beings, population and human health will not arise.

19.4.2.3 Interaction of Traffic with Noise and Vibration

Construction Phase

Construction traffic will generate noise emissions and there is a potential for noise impacts from construction traffic along public roads. A noise and vibration assessment of the noise emissions due to construction traffic identified that all bar three roads (Bearna to Moycullen, Cappagh Road and Bóthar Nua) will experience a potential increase in noise in the order of less than 3dB over a worst case scenario of a 12-month construction period.

The Bearna to Moycullen Road will experience an increase of 3dB and whilst this is perceptible the overall noise level along this road is of low to moderate level, calculated at 56dB $L_{Aeq,\,T}$ at 10m from the road edge and the overall impact is deemed to be moderate, short-term. Cappagh Road will experience an increase of 8dB and whilst this is perceptible the overall noise level along this road is of low to moderate level, calculated at 56dB $L_{Aeq,\,T}$ at 10m from the road edge and the overall impact is deemed to be moderate, short-term. Bóthar Nua will experience an increase of 7dB and whilst this is perceptible the overall noise level along this road is calculated at 62dB $L_{Aeq, T}$ at 10m from the road edge and the overall impact is deemed to be major, short-term.).

These impacts will be short-term and the use of best practice noise control measures, hours of operation, scheduling of works within appropriate time periods, will ensure impacts are controlled as far as practicable during the construction phase along public roads. Therefore, significant residual impacts from construction traffic on noise and subsequently human beings, population and human health will not arise.

Vibration impacts relating to construction traffic will be limited given the low generation of vibration from vehicles along well maintained roads. Therefore, significant residual impacts from construction traffic on vibration and subsequently human beings, population and human health will not arise.

Operational Phase

Traffic during the operational phase of the proposed road development will generate new noise emissions. Noise levels will be increased at the majority of noise sensitive locations along the length of the proposed road development. Whilst noise levels of varying increases and impact magnitudes are calculated at the assessment locations, the incorporation of a low noise road surface and the use of noise barriers along the roadside boundary will reduce noise levels to within the design goal of 60dB L_{den} or to the pre-existing Do Minimum noise levels at the majority of noise sensitive locations. Residual noise levels at a small number of locations will remain above the 60dB L_{den} design goal by 1 to 2dB. The noise assessment has concluded that changes in road traffic noise levels will be negligible to major in accordance with DMRB guidance, however the overall impact at the properties taking account of typical population response to the absolute noise levels under consideration across the study area is negligible to moderate.

Overall, noise levels will be increased at properties along the route of the proposed road development once operational and a change in the noise environment will occur. The proposed road development, however, has been designed to reduce operational noise levels to within national design guidelines through the incorporation of detailed noise mitigation measures. The number of properties along its route is relatively low compared to those within the city centre which are currently exposed to significantly higher noise levels from passing road traffic. The reduction in high volumes of traffic traversing the city centre will result in a moderate to major positive noise impact to an extensive number of noise sensitive properties along the existing road network.

Therefore, significant residual impacts from operational traffic on noise and subsequently human beings, population and human health will not arise.

19.4.2.4 Interaction of Traffic with Biodiversity

Construction Phase

The generation of traffic during the construction phase has the potential to negatively impact on biodiversity resulting in temporary severance or disturbance issues. Construction traffic and other construction activities such as watercourse crossings can present as a temporary barrier and/or hazard to mobile species such as otter, bats, badger, and fish potentially resulting in temporary severance and/or mortality. Furthermore, the physical presence of construction traffic can result in temporary disturbance to these species. Mitigation measures have been incorporated into **Chapter 8, Biodiversity** to address these potential impacts. These include measures such as exclusion zones around badger setts, construction measures for working along watercourses and strict controls on temporary crossing points over watercourses and temporary crossing points for bats. As a result of the implementation of such mitigation measures, significant residual impacts on biodiversity due to construction traffic will not arise.

Operational Phase

The generation of traffic and the physical presence of the proposed road development during the operational phase has the potential to negatively impact on biodiversity resulting in severance, disturbance and mortality issues. Mobile species such as bats, barn owls and other birds could potentially collide with traffic or structures resulting in mortality. The flight paths of bats could also potentially be severed due to the physical presence of the proposed road development. Furthermore, the introduction of lighting in otherwise unlit areas could potentially negatively impact bat activity.

As discussed previously, these types of impact interactions were identified at a very early stage in the design and environmental assessment process. As a result, the potential impacts were either avoided altogether through design measures or they were addressed through specific mitigation measures in the relevant EIA chapters. For example, the choice of the design of the River Corrib Bridge included an objective to minimise potential ecological impacts on birds due to collision risks and bats. Mammal underpasses and the Castlegar Wildlife Overpass were all designed with an objective to minimise the barrier effect for bats. Landscape planting has specifically been designed to minimise barn owl and bat mortality arising from collisions with traffic. Further mitigation measures have also been incorporated into **Chapter 8, Biodiversity** to further address these potential impacts. As a result of the implementation of design measures and other mitigation measures, significant residual impacts on biodiversity due to operational traffic and the physical presence of the proposed road development will only arise in relation to the Peregrine falcon. The presence of the proposed road development has the potential to permanently displace nesting Peregrine falcon from the nest site at Lackagh Quarry Refer to **Chapter 8, Biodiversity** for further details.

19.4.2.5 Interaction of Traffic with Soil, Water Quality and Resource and Waste Management

Construction Phase

During the construction phase, there is the potential for interaction between soil, water quality, resource and waste management and construction traffic. As mentioned previously, if excavated materials or demolition materials require disposal offsite or if construction materials are required to be imported, these activities have the potential to generate construction traffic volumes. For example, excavation activities will generate material (direct impact on soil and rock resource) some of which will require transportation (secondary impact on construction traffic) and disposal (secondary impact on resource capacity offsite). Construction traffic will also produce sediment runoff through potential spillage of saturated silts and peat slurry during the haulage of materials. This has the potential to impact on water quality. The interaction of water quality with human beings and biodiversity is discussed further below.

During the design process, every effort was made to balance the import and export volumes of materials thereby minimising construction traffic generation in the first instance. In addition, the Construction and Demolition Waste Management Plan (as presented in the Construction Environmental Management Plan (CEMP) in **Appendix A.7.5**) has been prepared to ensure that waste arising during the construction and demolition phase will be managed and disposed of in a way that ensures compliance with the provisions of the Waste Management Acts 1996-2011 and associated Regulations (1996-2011) to ensure that optimum levels of reduction, re-use and recycling are achieved. Furthermore, the Construction Traffic Management (CTMP) (as presented in the CEMP in **Appendix A.7.5**) has been prepared to ensure that construction traffic will be managed and monitored safely and efficiently throughout the construction phase. As a result of the implementation of mitigation measures such as the CEMP and the design measures, significant residual impacts from material imports and exports on construction traffic will not arise.

19.4.2.6 Interaction of Traffic with Material Assets

Construction Phase

The generation of construction traffic will result in road diversions and general short term disruption for properties in the area which could potentially negatively impact on residential, commercial and agricultural areas.

There are two locations where temporary road diversions will be in place in order to construct bridge structures at Ch. 3+300 Aille Road L5384 and Ch. 13+150 School Road, Castlegar L2134. Temporary night-time closure of existing roads may be required where overbridges are to be constructed at locations such as the Rahoon Road, Letteragh Road, N59 Moycullen Road, Menlo Castle Bóithrín, Bóthar Nua, An Seanbóthar, N84 Headford Road, N83 Tuam Road, Briarhill Business Park Road and R339 Monivea Road. The north end of the Anne Gibbons road will also be permanently closed with property access to the south maintained.

As detailed in the CEMP (**Appendix A.7.5**), the Contractor will put in place a Public Communications Strategy which will include procedures to inform members of the community who will be directly affected by the construction phase on schedules for any activity of a particularly disruptive nature which is likely to impinge on their property such as blasting, demolition, road closures and diversions, pile driving and any mitigating actions that are being taken (shielding, restriction on work hours, etc.) to minimise such disruption.

Furthermore, the Construction Traffic Management (CTMP) (as presented in the CEMP in **Appendix A.7.5**) has been prepared to ensure that construction traffic will be managed and monitored safely and efficiently throughout the construction phase. Therefore, significant residual impacts will not arise.

Operational Phase

The north end of the Anne Gibbons road will also be permanently closed with property access to the south maintained.

The indirect interaction of traffic with material assets is assessed elsewhere under the heading of air quality, noise and vibration, landscape and visual and human beings, population and human health.

19.4.2.7 Interaction of Traffic with Human Beings, Population and Human Health

Construction Phase

Construction traffic will be restricted to the designated haul routes. There will however be a temporary increase in traffic on these routes during construction, affecting the journey amenity of other road users and the general amenity of local residents. There will also be a requirement for some temporary road diversions and night time closures which would mainly result in slight negative impacts on journey time. As a result, there will be a slight impact for some people due to an increase in journey times. The Construction Traffic Management Plan included in the CEMP in **Appendix A.7.5** has been prepared to ensure that construction traffic will be managed and monitored safely and efficiently throughout the construction phase and includes designated traffic routes, timings and parking arrangements to be updated by the contractor prior to the commencement of construction.

The potential for impacts on human beings, population and human health arising from air and noise emissions generating from construction traffic was also identified. Refer to **Sections 19.4.2.2** and **19.4.2.3** above. Significant residual impacts from construction traffic on air quality and noise and vibration and subsequently human beings, population and human health will not arise.

Employment will be generated during the construction phase and will provide a positive economic impact to the local economy in terms of spending on food and accommodation, although a proportion of workers are likely to reside in Galway. The employment multiplier for similar infrastructure projects has been estimated at 1.5, implying the creation of one additional full-time equivalent jobs for every two people employed full-time on the construction of the proposed road development.

Social severance of communities will arise during construction due to works such as the movement of construction traffic, although physical connectivity will be maintained with the exception brief temporary restrictions to movement.

Some agricultural properties will also experience severance. Temporary alternative access routes and permanent utility diversions will be required during construction.

Operational Phase

During operation, some commercial properties such as service stations will experience a reduction in passing trade due to the diversion of traffic from some areas in Galway City and its environs.

The proposed road development will alleviate traffic congestion within Galway City and its environs and will therefore have a positive impact on the local and the larger regional population of Galway and the western region. This will improve the quality of life of those living within Galway City due to a reduction in traffic volumes and congestion, reduced pollution and reduced social and physical severance. The redistribution of traffic will significantly improve traffic movement in Galway City and its environs overall, thereby making it easier for people to work and travel through the city. The diversion of traffic from Galway City Centre to the proposed road development and the consequent freeing up of road space for pedestrian, cyclist and public transport use will result in a positive indirect impact on journey times and journey amenity. Along the route of the proposed road development, the presence of the road itself will remain a source of social severance, although physical connectivity will be maintained.

19.4.2.8 Interaction of Traffic with Risks of Major Accident and/or Disaster

Construction and Operational Phase

The vulnerability of the proposed road development to risks associated with major accidents and/or disasters was assessed. A major traffic collision was identified as such an event. Although, the consequence of this is ‘very serious’, resulting in mass injury or loss of life, the likelihood is considered to be low. All possible measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence vehicular accident events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential consequences of vehicular accident events.

19.4.2.9 Overview of Soil Interactions

Construction Phase

The construction of the proposed road development will include soil activities such as earthworks and excavations. These activities will generate air, noise and vibration emissions which could potentially create negative impacts on a number of environmental factors such as air quality and climate, noise and vibration, biodiversity, human beings, population and human health, material assets (both agriculture and non-agriculture).

The level of emissions generation is dependent on the types, intensity and duration of construction activities taking place. For example, if there are significant volumes of excavated material or demolition materials which require disposal offsite or if significant materials are required to be imported on site, these activities have the potential to generate construction noise and dust. These interactions are discussed further below in the interactions of air emissions and noise and vibration emissions.

Earthwork movement and excavations will also create landscape and visual impacts and generate waste materials. These are discussed further below.

19.4.2.10 Interaction of Air Emissions with Human Beings

Construction Phase

The construction of the proposed road development will require earthworks, particularly during site clearance and excavation. These activities have the potential to generate significant air emissions (dust) which could potentially negatively impact on human beings under the environmental topic of both human beings, population and human health and material assets (both agriculture and non-agriculture). In general, any additional airborne concentrations of particulate matter arising from construction would be small and very local to the construction activity (minimising human exposure). Particles generated by most construction activities tend to be larger than 10µm in diameter which are too large to enter the human lungs. An assessment was carried out of the potential dust impacts at locations where the main construction activities will take place and where the construction compounds will be located (Refer to **Section 16.5** of **Chapter 16, Air Quality and Climate**). The results of the assessment indicate that there are a number of receptors located within 100m of the construction activities/construction compounds where there is potential for significant soiling effects to arise with standard dust control mitigation measures in place. These soiling effects could impact both residential, commercial and agricultural areas for example and also in ecologically sensitive areas such as Lough Corrib cSAC.

Further mitigation measures have been designed to minimise the impact of dust and other air emissions during the construction phase. (Refer to **Section 16.6.2** of **Chapter 16, Air Quality and Climate**). These measures are based on best practice as outlined in the British Research Establishment (BRE) document ‘Controlling particles, vapour and noise pollution from construction sites’ and the Institute of Air Quality Management (IAQM) ‘Guidance on the assessment of dust from demolition and construction’, 2016. Furthermore, dust screens will be implemented at locations where there is the potential for air quality impacts during the construction phase as outlined in **Section 16.5.3** of **Chapter 16, Air Quality and Climate** i.e. at locations where sensitive receptors are located within 100m of the works.

Dust deposition and $PM_{10}/PM_{2.5}$ monitoring shall be carried out to confirm the effectiveness of the mitigation measures. The residual impact on air quality during the construction phase will not be significant following the implementation of mitigation measures outlined above.

As noted above, the results of the air quality assessment show that all of the predicted concentrations are in compliance with the air quality standards (Refer to **Table 16.20** of **Chapter 16, Air Quality and Climate**). Therefore, significant residual impacts on air quality and subsequently human beings, population and human health will not arise.

Operational Phase

Air emission from traffic on the proposed road development during the operational phase have the potential to generate negative impacts on human beings, population and human health.

The potential impact on air quality during the operational phase was assessed. Pollutant concentrations were provided at the worst-case receptors, i.e. those properties that are closest to the affected links. (Refer to **Section 16.5.4** of **Chapter 16, Air Quality and Climate**). The pollutants assessed included NO_2, PM_{10}, $PM_{2.5}$, CO and Benzene. The results of the assessment show that the predicted changes in concentration of all the pollutants are in compliance with the air quality standards. Therefore, significant residual impacts from operational traffic on air quality and subsequently human beings, population and human health will not arise.

Air quality improvements will improve at a number of locations during the operational phase due to decreases in annual average daily traffic (AADT) levels. The reduction in traffic will result in a localised improvement of air quality in these regions, which will be particularly evident where sensitive receptors are adjacent to roadways and traffic reductions are substantial. Refer to **Table 16.28** of **Chapter 16, Air Quality and Climate** for further details. Therefore, positive impacts will arise for human beings, population and human health at a number of locations due to the improvement in air quality during the operational phase.

19.4.2.11 Interaction of Air Emissions with Biodiversity

Construction Phase

As noted above construction activities such as earthworks, particularly during site clearance and excavation have the potential to generate significant air emissions (dust) which could potentially negatively impact on biodiversity. An assessment was carried out of the potential dust impacts at locations where the main construction activities will take place and where the construction compounds will be located. The results of the air assessment indicate that with standard dust control mitigation measures in place there is still potential for significant soiling effects to arise in ecologically sensitive areas such as Lough Corrib cSAC.

As noted above further mitigation measures have been designed to minimise the impact of dust and other air emissions during the construction phase. In addition to those measures noted above, a 2m dust screen will be provided at the locations in the areas of the overlap of the proposed road development and the Lough Corrib cSAC.

Dust deposition and PM_{10}/$PM_{2.5}$ monitoring shall be carried out to confirm the effectiveness of the mitigation measures. The residual impact on air quality during the construction phase will not be significant following the implementation of mitigation measures outlined above.

Operational Phase

Air emission from traffic on the proposed road development during the operational phase also have the potential to generate negative impacts on biodiversity.

An assessment was carried out on the potential for air pollution to impact on the Lough Corrib cSAC due to operational traffic under the headings of nitrogen compounds, Volatile Organic Compounds (VOC), metals/dust and ammonia at the River Corrib Bridge between Ch. 9+250 and Ch. 9+600, between Ch. 9+800 and Ch. 10+100 at Menlough, and Lackagh Tunnel between Ch. 10+450 and Ch. 11+450. The assessment shows that all predicted NO_x concentrations are in compliance with the Air Quality Standard for the protection of vegetation. The proposed road development contribution to the NO_2 dry deposition rate along the 200m transect from the proposed road edge was also calculated as detailed in **Table 16.23** of **Chapter 16, Air Quality and Climate**. The maximum increase in the NO_2 dry deposition rate is approximately 20% of the critical load for the lower boundary limit of inland and surface water habitats of 5-10kg(N)/ha/yr (TII 2011). Even with the addition of background levels, compliance with the critical load is achieved.

No critical load limits exist for VOCs for the protection of vegetation. An assessment of emissions of benzene was carried out for the proposed road development and predicted concentrations including background levels were well within the air quality standard for the protection of human health. Significant impacts arising from metals/dust and ammonia will not arise as they are all in compliance with the air quality standards. The air quality standards been developed to protect the environment as a whole. Refer to **Chapter 16, Air Quality and Climate** for further details. In summary, significant residual impacts from operational traffic air pollutants on vegetation along the route of the proposed road development are not likely.

19.4.2.12 Interaction of Noise and Vibration Emissions with Human beings

Construction Phase

Construction traffic movements and construction activities such as blasting, rock breaking and general earthworks have the potential to generate significant noise and vibration emissions which could potentially negatively impact on human beings under the environmental topic of both human beings, population and human health and material assets. A number of examples of locations where blasting and drilling may be required (which have the potential to experience impacts) are provided below.

Construction of the N59 Link Road North involves deep excavation towards the N59 Moycullen Road tie in, therefore a substantial volume of soil and rock excavation will be required which will likely require drill and blasting excavation.

The closest noise sensitive locations are approximately 50m from the excavation works. In the absence of specific noise mitigation measures, it is likely that construction noise limits during, day, evening and weekend periods will be exceeded, specifically during the intermittent use of high noise activities (rock drilling, crushing and breaking, if required). The use of specific noise mitigation measures will be applied in this area therefore including scheduling of works, choice of plant and screening.

Construction of the N59 Letteragh Junction involves an extensive area of cutting which will likely require drill and blast excavation. The closest noise sensitive locations are approximately 25m from the excavation works. Whilst excavation works will take place within the cutting area, it is likely that crushing and regrading works will take place within the proposed site compound located along the N59 link Road North which is set back from noise sensitive properties. Notwithstanding the above, given the close distances of excavation works to noise sensitive properties, the use of controlled noise mitigation measures will be required in this area to reduce construction noise levels at the nearest noise sensitive locations.

Construction of the Lackagh Tunnel will be undertaken in an east to west direction using drill and blast techniques. The tunnel portal and main works area will be within the proposed site compound at Lackagh Quarry. The closest noise sensitive properties to the tunnel are over 500m away and hence are well set back from the main excavation works in this area.

Construction of the N84 Headford Road Junction and the cutting on the eastern side of Lackagh Quarry will involve substantial earthworks for both cutting and embankment construction. There will be a large cutting into the eastern face of Lackagh Quarry within the eastern end of this section of the proposed road development which is located some 300m from the nearest noise sensitive locations. Construction of the N84 Headford Road Junction will involve extensive engineered fill works to cross the existing N84 Headford Road with an element of cutting required for slip roads. The closest noise sensitive locations are within 40 to 50m from these works and hence there is potential for construction noise levels to exceed daytime, evening and weekend construction noise criteria in the absence of noise mitigation measures.

As detailed previously, these potential impacts were identified at a very early stage in the design and environmental assessment process. As a result, the potential impacts have been addressed through specific mitigation measures in **Chapters 9, Soils and Geology** and **17, Noise and Vibration** and in the CEMP in **Appendix A.7.5**.

For example, the schedule of commitments specify that the contractor, undertaking the construction of the works, will be obliged to take specific noise abatement measures and in particular blast design control must comply with the best practice outlined in British Standard BS 5228 – 1: 2009 +A1 2014: *Code of practice for noise and vibration control on construction and open sites – Noise* and the NRA (now TII) guidelines *Good Practice Guideline for the Treatment of Noise during the planning of National Road Schemes* (National Roads Authority, 2014). Refer also to **Chapter 17, Noise and Vibration**.

Furthermore, a designated noise liaison officer will be appointed to site during construction works. Clear forms of communication will be established between the contractor and residents in noise sensitive areas in proximity so that residents or occupants of businesses are aware of the likely duration of activities likely to generate higher noise or vibration. All noise complaints will be logged and followed up in a prompt fashion by the liaison officer.

Mitigation measures have also been considered for potential vibration impacts. The TII Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities should be limited to the values set out in **Table 17.3** of **Chapter 17, Noise and Vibration**.

On review of the likely vibration levels associated with construction activities, it may be concluded that the construction of the proposed road development is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or cosmetic damage to buildings. Property condition surveys will be offered for all buildings within 50m of the proposed development boundary and those within 150m of proposed blasting works along the proposed road development. Property condition surveys will also be carried out at buildings and structures considered appropriate relative to their proximity to the works. Mitigation measures have also been proposed for vibration sensitive manufacturing facilities within the industrial estates at Parkmore and Ballybrit, refer to **Chapter 17, Noise and Vibration** for further details.

The results of the construction noise and vibration assessments have been taken into account in the assessment of human health (Refer to **Chapter 18, Human Beings, Population and Health**) and concludes that significant residual impacts from noise and vibration emissions (arising from construction traffic and other construction activities) on human health will not arise.

Operational Phase

The noise emission sources from the proposed road development during the operational phase will be from traffic. These emissions have the potential to negatively impact on human health. Traffic noise levels have been calculated at many noise sensitive locations along the length of the proposed road development and mitigation has been identified for a number of locations (Refer to **Table 17.13** of **Chapter 17, Noise and Vibration**). The mitigation measures required to reduce traffic noise levels are specified based on the predicted noise levels for the Design Year of 2039. The results of the modelling exercise show that noise mitigation is required for 102 properties along the route of the proposed road development for this Design Year.

Measures to reduce operational noise levels along the proposed road development include the use of a Low Noise Road Surface (LNRS) to reduce noise generated at source and the use of noise barriers to reduce noise levels along the propagation path between the source (proposed road development) and the specific receivers (houses, schools, churches etc.). These screens may be constructed as earth bunds, proprietary noise barriers or a combination of both. The use of a low noise road surface (LNRS) will provide a mean reduction in traffic noise level of -2.5dB compared to Hot Rolled Asphalt (HRA) along the length of the mainline of the proposed road development and along the main junction slip roads accessing the

N59 Moycullen Road, N84 Headford Road, N83 Tuam Road and existing N6 in addition to the N59 Link Road North and South as part of the proposed road development. **Table 17.14** of **Chapter 17, Noise and Vibration** summarises the noise barrier requirements for the proposed road development.

During the operational phase, noise levels will be increased at the majority of noise sensitive locations along the length of the proposed road development. Whilst noise levels of varying increases and impact magnitudes are calculated at the assessment locations, the incorporation of a low noise road surface and the use of noise barriers along the roadside boundary will reduce noise levels to within the design goal of 60dB L_{den} or to the pre-existing Do Minimum noise levels at the vast majority of noise sensitive locations. Residual noise levels at a small number of locations will remain above the design goal but are within 3dB of the design goal or are less than the predicted noise level in the Do-Minimum scenario. The assessment has concluded that changes in road traffic noise levels will be negligible to major in accordance with DMRB guidance, however the overall impact at the properties taking account of typical population response to the absolute noise levels under consideration across the study area is negligible to moderate.

Overall, noise levels will be increased at properties along the route of the proposed road development once operational and a change in the noise environment will occur. The proposed road development, however, has been designed to reduce operational noise levels to within national design guidelines through the incorporation of detailed noise mitigation measures. The number of such properties along its route is relatively low compared to those within the city centre which are currently exposed to significantly higher noise levels from passing road traffic. The reduction in high volumes of traffic traversing the city centre will result in a moderate to major positive noise impact to an extensive number of noise sensitive properties along the existing road network.

The results of the operational noise assessments have been taken into account in the assessment of human health (Refer to **Chapter 18, Human Beings, Population and Health**) and concludes that significant residual impacts from noise emissions (arising from operational traffic) on human health will not arise. Equally there will be no significant residual impacts on material assets arising from noise emissions.

19.4.2.13 Interaction of Vibration Emissions with Soil

Construction Phase

The soils and geology assessment also considered the potential vibration impacts arising from blasting and tunnelling on geology and in particular at the locations described above such as the Lackagh Tunnel. As noted previously, these potential impacts were identified at a very early stage in the design and environmental assessment process. As a result, the potential impacts have been addressed through specific mitigation measures in the **Chapters 9, Soils and Geology** and **17, Noise and Vibration** and in the CEMP in **Appendix A.7.5**. For example, ground settlement, horizontal movement and vibration monitoring will be implemented during construction activities to ensure that the construction does not exceed the design limitations.

In situations where the site specific blast design has determined that blasting is not feasible in a particular location due to excessive ground vibrations, alternative extraction methods such as hydraulic breaking, hydraulic splitting, chemical splitting and electrical disintegration may be implemented and monitored. Monitoring will be implemented during blasting, during excavation of cuts, for overburden slopes steeper than 1V:2H (V= vertical slope, H = horizontal slope) and rock slopes steeper than 1V:1.5H.

A geotechnical expert will be appointed by the contractor and will be present to monitor the surrounding ground vibrations near sensitive receptors during blasting works. In the unlikely event that the blast vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring.

The tunnelling construction methodology at Lackagh Tunnel has specifically considered potential impacts on geology and in particular the Annex I habitats at the surface, namely Limestone pavement and Calcareous grassland. Again, a geotechnical expert will be appointed by the contractor and will be present to monitor the rock mass stability during their construction period. In the unlikely event that instability within the rock mass is observed, additional support measures will be installed to ensure that there is no impact to the surface above. The additional rock support measures comprise ground anchors, rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures, designed to the relevant design standards and best practice guidance documents. However, based on the conservative design approach it is considered that the risk of instability will be avoided and additional support measures will not be required.

Furthermore, a geotechnical expert will be appointed by the contractor and will be present to monitor the vibrations at the surface, including the areas of Limestone pavement, during blasting works for the construction of Lackagh Tunnel and its Western Approach. The blast target vibration limit is defined as 20% more conservative than the conservative design approach vibration limit of 25mm/sec at the ground surface which includes areas of Limestone pavement, which provides an added factor of safety to the construction works to ensure that blasting will not impact the structural integrity of the Limestone pavement. In the unlikely event that the blast target vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring.

Therefore, significant residual vibration impacts from blasting/tunnelling (arising from construction activities) on soils and geology will not arise.

19.4.2.14 Interaction of Noise and Vibration Emissions with Biodiversity

Construction Phase

The biodiversity assessment also considered the potential impacts of blasting at the locations identified above including potential impacts on wintering birds at Ballindooley Lough.

As noted above, these potential impacts were identified at a very early stage in the design and environmental assessment process. As a result, the potential impacts have been addressed through specific mitigation measures in the **Chapters 8, Biodiversity**, **9, Soils and Geology** and **17, Noise and Vibration** and in the CEMP in **Appendix A.7.5**.

For example, blasting associated with the eastern approach to Lackagh Quarry (Ch. 11+800 to Ch. 12+100) and the cutting at Castlegar (Ch. 12+550 to Ch. 13+650) will be carried out between the months of April to September (inclusive) to minimise the exposure of wintering birds at Ballindooley Lough to blasting-related disturbance. Refer also to **Chapter 8, Biodiversity**, **Chapter 9, Soils and Geology** and **Chapter 17, Noise and Vibration**.

The biodiversity assessment also considered the potential impacts of disturbance to the Peregrine falcon due to noise. Despite the mitigation measures proposed, a significant residual impact on Peregrine falcon due to noise during construction remains. Refer also to **Chapter 8, Biodiversity**.

Therefore, the only significant residual impacts from noise emissions (arising from construction traffic and other construction activities) on biodiversity is disturbance to the Peregrine falcon.

Operational Phase

There will be a significant residual impact on Peregrine falcon due to potential noise disturbance from road traffic during the operation of the proposed road development.

19.4.2.15 Interaction of Biodiversity with Human Beings

Construction and Operational Phase

Interactions exist with biodiversity whenever human beings interact with the natural environment. These could be realised in two ways by:

- activities giving rise to impacts on biodiversity
- the presence ecosystem services, with biodiversity at the heart, which have the capacity to regulate and support the natural environment that contributes to human well-being

In the context of the proposed road development, potential impacts arise due to the presence of biodiversity and the benefits that biodiversity provides in terms of amenity or passive enjoyment of the landscape. The design of the proposed road development took cognisance of ecosystem services and sought to protect water quality and air quality and prevent soil erosion. It also sought to maintain local biodiversity which can be enjoyed by human beings.

The River Corrib for example is used by many people for recreational purposes, both on the water (rowing or angling) and along its banks (walking). Many species including Otter and bats, fish including salmonids, and birds utilise this corridor also. Angling is directly reliant on biodiversity. The River Corrib is an important salmonid river and consequently of importance for angling, therefore the protection of river water quality is essential for both biodiversity and amenity of the River Corrib corridor. Equally the presence of the fauna listed above and the flora along the river sides makes it an enjoyable place to walk or row, enhancing a person's recreational experience and contributing to their well-being. The proposed road development does not impact on this ecosystem service, which ultimately contributes to human well-being.

The interaction between biodiversity and human beings has been considered for example in the design of the River Corrib Bridge. Factors such as no piers in the water which would minimise impacts on aquatic biodiversity and amenity use of the river, type of structure to minimise bird collision risk and the aesthetics appearance of the bridge were all considered in the design thus protecting this ecosystem.

The principal focus of amenity activity is the River Corrib corridor, but interaction of biodiversity and human beings and well-being occurs throughout the study area. Some other natural environments, for example wetlands east of the River Corrib in the vicinity of Menlough and Ballindooley, contribute regulating and cultural ecosystem services by moderating water flow and acting as habitat for valued wildlife species. Natural environments such as peatlands and limestone have a role in filtering water quality in the study area with potential economic and health implications, although the role of biological processes is greater in the former. Vegetation such as hedgerows, treelines and woodland also have a role in noise attenuation and air quality regulation. Potential impacts for the above interactions on water quality or soil erosion would apply mainly during the construction phase. Measures have been taken however, to mitigate these through the sediment control and pollution prevention controls described in the CEMP in **Appendix A.7.5** and on biodiversity in **Section 8.6** of **Chapter 8, Biodiversity**.

19.4.2.16 Interaction of Archaeology, Architectural and Cultural Heritage with Biodiversity

Construction and Operational Phase

There is a potential for the archaeological trench testing along the route of the proposed road development to impact on biodiversity. These potential impacts will be the same as those identified in **Chapter 8, Biodiversity** as a result of the construction of the proposed road development.

These is also an interaction between architectural and cultural heritage with biodiversity with the design of the River Corrib Bridge. This crossing of the River Corrib, will introduce a dominant new feature into its landscape corridor which will have an impact on the heritage of Menlo Castle. Menlo Castle is also a maternity roost of the Lesser Horseshow bat. The design of the River Corrib Bridge took cognisance of these constraints and mitigation measures such as additional planting are provided, however significant residual impacts will continue to arise on the lowland landscape valley of the River Corrib, and the setting of Menlo Castle.

19.4.2.17 Interaction of Archaeology, Architectural and Cultural Heritage with Human Beings

Construction and Operational Phase

The proposed road development will impact on archaeological, architectural and cultural heritage features which are of interest and importance to the local people. As noted previously, these potential impacts were identified at a very early stage in the design and environmental assessment process. As a result, the potential impacts have been addressed through specific mitigation measures in a number of chapters such as **Chapter 13, Archaeological, Architectural and Cultural Heritage, Chapter 12, Landscape and Visual** and **Chapter 18, Human Beings, Population and Human Health**. For example, the setting of Menlo Castle provides an area for amenity use. There is a potential for a change in the amenity of this area if there is a change in the setting as a result of the River Corrib Bridge. This is discussed further under the heading of the interaction of landscape and visual with human beings. Menlo Castle is an important element of this setting. Whilst the proposed archaeological mitigation measures will record the current context of Menlo Castle, they will not fully remove the residual impact of the proposed road development on the setting of Menlo Castle – post mitigation the operation of the proposed road development will have an indirect moderate negative impact on the castle.

Other interaction examples include an occupied thatched cottage at Castlegar which is also a protected structure which will be demolished to facilitate the construction of the proposed road development. Prior to demolition, the thatched cottage will be subject to a full measured, written and photographic survey. This will be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. There is also a mass path located at Parkmore which is of heritage and amenity value for local people. The design of the Parkmore Link Road was revised to maintain access along this mass path. Archaeological testing and a written and photographic record prior to construction will also be carried out. Once the recommended mitigation measures have been applied (to the mass path and thatched cottage), there will be no residual impact on the archaeological, architectural or cultural heritage resource as a result of the construction of the proposed road development

19.4.2.18 Interaction of Landscape and Visual with Material Assets and Human Beings, Population and Human Health

Construction and Operational Phase

The landscape character and existing views in the area will change during both the construction and operational phases of the proposed road development. This impact has the potential to interact with people, both in terms of landscape and visual impacts where they live, work and their use and “experience” of surrounding amenities.

Lighting impacts both from the proposed road development itself and from traffic using the proposed road development during operation have the potential to impact on people. Similarly, lighting impacts from construction compounds during winter months have the potential to impact on people, depending on where they are situated.

Mitigation measures are proposed to minimise impacts during construction and include the implementation of the CEMP; provision of hoarding; careful location of storage areas to avoid impacting on residential and commercial properties and trees; and the decommissioning and reinstatement of construction compound areas to their pre-construction condition at the end of the construction contract.

The introduction of the proposed road development will change the views and landscape character of the area in varying degrees, some areas will require mitigation planting to screen impacts, other areas will experience views of the proposed road development. These changes have the potential to impact on people, especially in residential areas.

During the operation stage, visual impacts will arise from the physical built presence of the proposed road development, including its significant structures, elevated embankments, deep cuttings, traffic usage and additional illumination both fixed and from vehicles, especially where the proposed road development is on embankment or at junctions and bridging locations. In open views, embankments have the potential for visual obstruction and significant visual intrusion. Deep cuttings can also result in significant change to the visual nature of landscape continuity. These visual impacts have the potential to significantly impact on material assets non-agriculture such as such as residential areas. As discussed previously, these potential interactions of impacts were identified at a very early stage in the design process and many of them have been addressed/minimised through design measures and also through specific mitigation measures in the relevant EIA chapters.

For example, measures for the mitigation of potential noise impact will be required at a number of locations along the proposed road development, especially where residential properties are in close proximity to the carriageway. Such noise impacts and mitigation measures are considered in detail in **Chapter 17, Noise and Vibration**. Mitigation measures will involve the provision of barriers or earth bunds or a combination of such features. While initially these features may increase the visual presence of the proposed road development, they also provide for immediate visual screening of the proposed road development and its associated traffic. In the majority of circumstances these features can also be appropriately incorporated into the proposed landscaping measures.

The proposed road development also includes for realignments/tie-ins to existing national, regional and local roads, together with drainage works and accommodation measures, all of which have potential for localised visual impacts. Local road realignment is important as many residential properties tend to be located along such roads and local direct impacts can arise.

A full schedule and description of visual impacts on properties is set out in the Visual Impact Schedule (VIS) Tables in **Appendix A.12.1** and on **Figures 12.1.01** to **12.1.14**.

In the pre-establishment stage, 71 of the 351 locations (c.20%) will have an imperceptible impact. A further 167 locations (c.48%) will have a slight or moderate short-term impact. Eighty-four locations (c.24%) will have significant or very significant short-term visual impact. The remaining 29 locations (c.8%) will experience profound short-term negative visual impact associated with the presence and early operation stage of the proposed road development.

As landscape measures establish and mature the level of visual impact will gradually recede so that in the post-establishment stage some 156 locations (c.44%) will have an imperceptible impact. A further 140 locations (c.40%) will have a slight or moderate medium-term impact. Thirty-four locations (c.10%) will have significant or very significant medium-term visual impact. The remaining 21 locations (c.6%) will continue to experience profound medium and longer-term negative visual impact associated with the proposed road development. Refer to **Figures 12.1.01** to **12.1.14** for locations of properties.

The properties with on-going significant and very significant visual impact are either located in more remote and rural areas and are in proximity to the proposed road development, or are in suburban areas and are located directly adjacent to the proposed road development.

19.4.2.19 Interaction of Landscape and Visual and Biodiversity

Construction and Operational Phase

The construction phase will require site clearance and will result in the removal of a variety of habitats. This biodiversity (and landscape) impact, such as the removal of a woodland area, has the potential to permanently interact with the landscape character and amenity (and biodiversity) of an area. In addition, there is a potential for a change in biodiversity (such as introduction/spread of non-native invasive plant species) to negatively impact on landscape and visual aspects.

These potential interactions of impacts were identified at a very early stage in the design and environmental assessment process and have been addressed through specific mitigation measures, such as planting, in the relevant EIA chapters. For example:

- Mitigation measures to avoid the introduction or spread of non-native invasive plant species to Moycullen Bogs NHA during construction or operation have been detailed in the Non-native Invasive Species Management Plan which forms part of the CEMP in **Appendix A.7.5**
- To minimise the loss of habitat associated with the proposed road development, there are also areas within the proposed development boundary which are included for mitigation planting where general construction works will not be undertaken. These are shown on **Figures 8.23.1** to **8.23.14**
- Planting of woodland, hedgerow and grassland habitats along the proposed road development as detailed in the landscape drawings (**Figures 12.2.01** to **12.2.14**) will provide compensatory habitat for some bird species. In some instances, such as in large areas of improved agricultural grassland with no vegetated field boundaries, this will improve the diversity of bird habitat
- Sections along the proposed road development, will be planted with dense low growing scrub cover (e.g. blackthorn) to discourage Barn owls from foraging near the proposed road development. The planting will be of a density to minimise the lag time between planting and obtaining sufficient ground cover to deter foraging Barn owl
- In areas where there is a high probability that Barn owls regularly attempt to cross the proposed road development (the section of embankment between Ch. 9+600 and Ch. 10+100), lines of closely spaced (approximately 2m centres) trees, greater than 3m in height, will be planted along the top of the embankments of the proposed road development; outside of the safety barrier and clear zone. The understorey will also be densely planted. This is to present a solid vegetated barrier to deflect Barn owl from these high-risk areas and/or force birds to fly over the proposed road development above the road traffic
- Specific landscape planting mitigation measures have been proposed to preserve flight paths for bats during both construction and operational phases. The Castlegar Wildlife Overpass is a critical component of the strategy and specific landscape planting has been designed on the approach to and over the overpass. The overpass will allow bats to fly across the proposed road development between the roosts and foraging habitats on the north side and Coopers Cave and foraging areas to the south at this location
- An area of habitat enhancement for the purposes of offsetting the loss of suitable bat habitat due to the proposed road development within the known core foraging area of the Menlo Castle Lesser horseshoe bat population is included with in the proposed development boundary. Hedgerows in this area will be augmented and thickets of hazel, hawthorn, holly and oak will be provided in several of the fields to create pockets of wood and grassland habitat. Grazing will continue on the lands as it has been shown that this improves the quality of this type of habitat for Lesser horseshoe bats. Connectivity to foraging areas will also be secured through tying the proposed planting strips to hedgerows and woodland edges. Planting of new hedgerows in fields between the proposed road development and Menlo Castle will improve the foraging resources of this core foraging area. Such planting will include additional native hedgerows planted across the existing fields to increase the lengths of hedgerows close to

the proposed new roost for Lesser horseshoe bats. The fields will still be grazed and the hedgerows can be fitted with field gates as required providing gaps are kept to a minimum.

The landscape planting mitigation measures proposed will significantly reduce the level of biodiversity residual impact.

19.4.2.20 Interaction of Landscape and Visual and Archaeology, Architectural and Cultural Heritage

Construction and Operational Phase

There is a potential for a change in the setting of archaeological, architectural and cultural heritage features if there is a change in landscape character or views. For example, the proposed road development, including a c.650m long bridge at the crossing of the River Corrib, high embankments and a c.320m long viaduct at Menlough will introduce a dominant new feature into its landscape corridor. The new bridge in particular will be prominent along the River Corrib and NUIG Sporting Campus and from Menlo Castle, while the embankments and viaduct on the east of the River Corrib cross a very remote and elevated semi-natural landscape. The bridge and viaduct, and particularly traffic on the structures, will also be visible where elevated vantage points on the west side of the river allow for viewing across the River Corrib valley.

Given the existing environment, and the nature of this section of the proposed road development, integration will be slow and structures such as the bridge and viaduct will permanently influence landscape character. There will be a profound short-term and very significant medium negative impact on local landscape character. In addition, there will be a significant archaeological, architectural and cultural heritage impact on Menlo Castle and its demesne. Mitigation measures such as landscape planting in the vicinity have been proposed to soften the impacts however significant residual landscape impacts will continue to arise on the lowland landscape valley of the River Corrib, and the setting of Menlo Castle.

19.4.2.21 Interaction of Soil and Water Quality with Human Beings, Population and Human Health and Material Assets

Construction Phase

The construction works will involve considerable earthworks throughout the proposed road development area including cuttings and embankments, tunnels, bridges and viaducts and the movement earthworks materials both within the proposed road development boundary and outside of the proposed road development boundary (quarries, borrow pits etc.). These works and other construction activities have the potential to impact on water quality, water supplies, people and material assets. These potential impacts were considered at a very early stage and pollution control measures have been incorporated into the design and specified in the CEMP.

As detailed in the CEMP in **Appendix A.7.5** and in **Section 11.6** of **Chapter 11, Hydrology**, a suite of mitigation measures has been proposed and include an Incident Response Plan (IRP) and Sediment, Erosion and Control Plan (SECP). Stringent mitigation and control of potential polluting activities associated with construction activities is proposed which will significantly reduce pollution risk. Stringent controls are proposed to limit the risk of untreated sediment run-off entering the water body and to minimise the risk of construction spillages of concrete and hydrocarbons into these waters (refer also to the CEMP in **Appendix A.7.5**). Specifically, there will be no in-stream works at the River Corrib channel associated with the construction of the river bridge crossing that fully spans the River Corrib channel, so as to protect the major downstream drinking water abstraction to the Galway City Water Treatment Plant at Terryland.

Mitigation measures to address impacts on water supplies from wells have also been considered (Refer to **Chapter 10, Hydrogeology**) and will include measures such as replacement wells, connections to mains supplies or financial compensation for wells which will be lost during the construction phase. Monitoring will also be carried out at some locations and standard mitigation measures and aquifer specific mitigation measures will also be employed for protection of groundwater. These measures will ensure that significant residual impacts on water supplies will not arise

Operational Phase

Potential pollution impacts during the operational phase (such as from operational traffic) on water quality have also been considered. The operational phase presents a potential pollution risk to the Terryland water supply both from accidental spillages and from routine road run-off discharges. However, pollution control measures have been designed and put in place to significantly reduce the risk. The proposed drainage system design incorporates a range of pollution control features to limit the water quality impact to receiving waters. These include filter drains, grassed surface water channels, petrol and oil interceptors, detention ponds, wetlands and infiltration basins and spillage containment areas. The use of filter drains and grassed surface water channels are proposed in non-sensitive groundwater areas (granite bedrock areas west of N59 Moycullen Road) where possible and closed (sealed) drainage systems are proposed in the highly vulnerable Karst Aquifer region east of the N59 Moycullen Road. A treatment wetland will be provided upstream of the attenuation pond at all proposed surface water outfalls and upstream of all infiltration basins outfalling to ground, from the mainline and its associated link roads of the proposed road development. Treatment wetlands are designed to capture the first flush rainfall events.

In addition to the treatment wetlands, oil and petrol interceptors along with spillage containment areas will also be placed upstream of all surface water outfalls and groundwater infiltration basins. The oil and petrol interceptor and isolated spillage containment areas provide protection against both minor and major road spillages. An operational spillage assessment for the proposed road development was carried out for all outfalls, both surface and groundwater, and the results show low risk of impact from serious accidental spillage involving a HGV. In conclusion, residual water quality impacts on these watercourses will be slight during the operational phase. Therefore, significant negative cumulative impacts will not arise.

19.4.2.22 Interaction of Soil and Water Quality with Biodiversity

Construction Phase

As noted above, the construction of the proposed road development has the potential to impact on water quality. This in turn has the potential to impact on biodiversity. These potential impacts were considered at a very early stage and pollution control measures have been incorporated into the design and specified in the CEMP.

As noted above a suite of mitigation measures including an IRP and SECP have been proposed which will significantly reduce pollution risk. Stringent controls are proposed to limit the risk of untreated sediment run-off entering the water body and to minimise the risk of construction spillages of concrete and hydrocarbons into these waters. As noted above there will be no in-stream works at the River Corrib channel associated with the construction of the river bridge and this will minimise effects on Lough Corrib cSAC and European designated sites downstream.

A section of Lackagh Tunnel passes under an area of Qualifying Interest (QI) Annex I habitats, namely Limestone pavement and Calcareous grasslands, within the Lough Corrib cSAC. Given the presence of Annex I habitats, the design of the tunnel and its approaches includes measures such as stabilisation of Lackagh Quarry Face around the eastern tunnel portal in order to prevent rock mass instability and slope instability, careful selection of the tunnel construction methodology, retaining systems and blast design limitations.

Furthermore, during the construction of Lackagh Tunnel the supported rock face of Lackagh Quarry Face and retaining walls for the Western approach will be monitored for movement. A geotechnical expert will be appointed, by the contractor and will be present to monitor the rock mass stability during the construction period for these specific works. In the unlikely event that instability within the rock mass is observed, additional support measures will be installed to ensure that there is no impact to the surface above. The additional rock support measures comprise ground anchors, rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures, designed to the relevant design standards and best practice guidance documents. However, based on the conservative design approach it is considered that the risk of instability will be avoided and additional support measures will not be required.

A geotechnical expert will be appointed by the contractor and will be present to monitor the vibrations at the surface, including the areas of Annex I habitats, during blasting works for the construction of Lackagh Tunnel and the Western Approach. The blast target vibration limit is defined as 20% more conservative than the conservative design approach vibration limit of 25mm/sec at the ground surface which includes areas of Annex I habitats, namely Limestone pavement and Calcareous grasslands, which provides an added factor of safety to the construction works to ensure that blasting will not impact the structural integrity of the Limestone pavement. In the unlikely event that the blast target vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring. Therefore, significant residual impacts will not arise.

Potential impacts on biodiversity arising from the introduction of material derived from a different lithology were also identified at an early stage in the design process. Specific mitigation measures have been included to address these impacts (Refer to **Section 9.5** of **Chapter 9, Soils and Geology**). For example, to prevent impact to the local peatland habitats, described in **Chapter 8, Biodiversity**, fill limitations at specific locations have been identified (Refer to **Table 9.18** of **Chapter 9, Soils and Geology**). Therefore, significant residual impacts will not arise.

Operational Phase

Potential pollution impacts during the operational phase (such as from operational traffic) on water quality and biodiversity have also been considered. The interaction assessment outlined above for soil and water with human beings is the same as that for biodiversity and significant negative cumulative impacts will not arise.

During the operational phase, monitoring of the rock mass stability will continue. The rock and overburden retaining systems in Lackagh Quarry and the Western Approach will continue to be monitored as part of the operational maintenance schedule. In the extremely unlikely event that instability within the rock mass is observed additional support measures as outlined above for the construction phase will be installed to ensure that there is no impact to the structural integrity of the Annex I habitats. However, based on the conservative design approach, (the installed composite support system and monitoring during construction) it is considered that the risk of instability will be avoided and additional support measures will not be required.

The measures described above were taken into account in the biodiversity assessment of this EIAR and in the NIS. The conclusion of the NIS was that the construction or operation of the Lackagh Tunnel and approaches will not affect the structural integrity of the rock mass supporting QI habitats in Lough Corrib cSAC or affect the conservation objective attributes and targets supporting the conservation condition of the QI habitats and species of Lough Corrib cSAC. Therefore, significant negative cumulative impacts will not arise.

Furthermore, during the operational phase of the proposed road development inspection and maintenance will occur to ensure that the infiltration basins continue to operate as intended for the design life of the proposed road development. If karst features and potential pathways are found to be present during inspection, then the Karst Protocol developed for the construction phase will be implemented to ensure that no preferential pathways have formed within the infiltration basin. Therefore, significant residual impacts will not arise.

19.4.2.23 Interaction of Water Quantity with Human Beings, Population, and Human Health and Material Assets

Construction and Operational Phase

Flooding can effect properties, including dwelling, commercial, industrial and agricultural or to effect journey movements. There are potential impacts on journey connectivity and amenity, residential amenity, economic activity and human health. The proposed road development as part of the design and environmental evaluation process has undergone a detailed Flood Risk Assessment in accordance with the DoEHLG Planning System and Flood Risk Management Guidelines for Planning Authorities. The assessment identified the sources of flood risk to the proposed road development from fluvial, pluvial and groundwater sources, but not from a coastal source as the proposed road development is sufficiently set back and elevated above the coastal zone. Overall the assessment has concluded that the design of the proposed road development minimises flood risk to the development itself and is rated as having a low probability of flooding.

A potential significant flood risk impact to lands including residential properties has been identified in the vicinity of the N83 Tuam Road Junction, resulting in the permanent encroachment and loss of some of the flood storage area from this flood risk area. Flood relief mitigation measures involving improved land and road drainage, provision of compensation storage and storm water pumping to the Terryland Basin have been designed, which when implemented will result in providing a residual moderate to significant positive impact by reducing the risk of serious flooding in this area.

At all other locations along the proposed road development, there will only be slight to imperceptible impacts on flood risk as very minimal encroachment of floodplains occur and design measures in the form of large culverts and stormwater attenuation ponds are included in the design. Residual flood risks exist at the drainage outfalls and their associated attenuation ponds and at the various culverts due to potential blockages. It should be noted however, the culverts have been sized with additional capacity for climate change impacts, controlled overflow systems are in place and there will be a program of regular inspections and maintenance and therefore the risk of blockages is slight.

Therefore, significant negative cumulative impacts will not arise.

19.4.2.24 Interaction of Water Quantity with Biodiversity

Construction and Operational Phase

The interaction of water quantity with biodiversity is the same as that presented above for the interaction of water quantity with human being, population and health and material assets. Significant negative cumulative impacts will not arise.

19.4.2.25 Interaction of Resource and Waste Management with Human Beings

Construction and Operational Phase

The interaction of resource and waste management with human beings, under the environmental topic of both human beings, population and human health and material assets, was considered. For example, the demolition of residential properties will generate demolition waste which will require transportation and disposal off site. Transportation requires construction traffic which can generate noise and air emissions which can impact on people. This has been addressed previously in **Sections 19.4.2.1** to **19.4.2.3** above.

During the design process, every effort was made to balance the import and export volumes of materials thereby minimising construction traffic generation in the first instance. In addition, the Construction and Demolition Waste Management Plan (as presented in the Construction Environmental Management Plan (CEMP)) has been prepared to ensure that waste arising during the construction and demolition phase will be managed and disposed of in a way that ensures compliance with the provisions of the Waste Management Acts 1996-2011 and associated Regulations (1996-2011) to ensure that optimum levels of reduction, re-use and recycling are achieved. Furthermore, the Construction Traffic Management (CTMP) (as presented in the CEMP) has been prepared to ensure that construction traffic will be managed and monitored safely and efficiently throughout the construction phase. As a result of the implementation of mitigation measures such as the CEMP and the design measures, significant residual impacts will not arise.

Lackagh Quarry will also be fully acquired to facilitate the construction of the proposed road development. This will result in a moderate impact on soils and geology due to the loss of a portion of future quarry or pit reserves. This will also result in a significant impact on a material asset impact. Financial Compensation for this impact is to be agreed by a valuer at a later stage after appropriate liaison with the property owners affected. Financial compensation does not form part of the EIA process and is therefore not considered further.

19.4.2.26 Interaction of Material Assets with Human Beings

Construction and Operational Phase

As described in **Chapter 15, Material Assets, Non Agriculture**, the proposed road development will cross through lands populated by residential and commercial properties on the outskirts of Galway City and include both agriculture lands and lands zoned for development. The proposed road development has been designed to avoid as many properties as possible, but given the distribution of development and the presence of linear type development of the city with housing along most roads radiating out of the city, its construction will unfortunately and unavoidably result in a number of property demolitions or acquisitions with some concentrations in particular areas. As well as the direct negative impact on the householders themselves, this will present a varying negative impact on remaining residents and at a community level depending on the strength of community interaction that has evolved at each location and the sustainability of community facilities such as schools. In several locations, and particularly in Na Foraí Maola and Troscaigh and the vicinity of the N59 Moycullen Road, the N84 Headford Road and in Castlegar, there will be a significant impact on local communities due to the need to acquire or demolish a high proportion of existing properties in these areas. It is important to recognise that the people whose homes will be subject to compulsory purchase across the route of the proposed road development have genuine concerns that their lives will be adversely affected. Many have lived in the area many years, or indeed, all of their lives.

In the event of an approval of the Protected Road Scheme and Motorway Scheme and approval under Section 51 of the Roads Act 1993 (as amended), by An Bord Pleanála and subject to the availability of funding, Notice to Treat will be served firstly on owners, lessees and occupiers of the dwelling houses and commercial properties to be acquired, within six months of the scheme becoming operative, unless an application has been made for Judicial Review, in which case the Notice to Treat will be served in accordance with the provisions of Section 217 (6A) of the Planning and Development Act 2000 as inserted by the Compulsory Purchase Orders (Extension of Time Limits) Act 2010. Compensation will be agreed or determined by the property arbitrator as soon as possible after service of Notice to Treat. After compensation has been agreed or determined and satisfactory title has been produced, part payment can be made while the claimant remains for an agreed period in the property to be acquired. This will facilitate the claimant in removing uncertainty and will facilitate arrangements being made, as early as possible, to secure a replacement property.

19.4.2.27 Interaction of Risks of Major Accident and/or Disaster and Human Beings, Population and Human Health

Construction and Operational Phase

The vulnerability of the proposed road development to risks associated with major accidents and/or disasters was assessed and potential interactions with human beings. A number of events were identified (Refer to **Table 19.1** above) such as major traffic collision (as described previously), hydrological and hydrogeological events, structural collapse events, tunnel fire events, service utility events and ground collapse events. As above, although, the consequence of these events is ‘very serious’, potentially resulting in mass injury or loss of life, the likelihood is considered to be low. The potential for low likelihood but potentially high consequence major accident and/or disaster events remains, although the possibility is extremely remote. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence events. Refer to **Section 19.2** above for further details.

19.4.2.28 Interaction of Risks of Major Accident and/or Disaster and Air Emissions, Noise and Vibration Emissions

Construction and Operational Phase

The vulnerability of the proposed road development to risks associated with major accidents and/or disasters and potential interactions with air, noise and vibration emissions was also assessed. A number of events were identified (Refer to **Table 19.1** above) such as major traffic collision (as described previously), structural collapse events, tunnel fire events, service utility events and ground collapse events. As above, although, the consequence of these events is 'very serious', potentially resulting in significant air, noise and vibration emissions, the likelihood is considered to be low. The potential for low likelihood but potentially high consequence major accident and/or disaster events remains, although the possibility is extremely remote. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence events. Refer to **Section 19.2** above for further details.

19.4.2.29 Interaction of Risks of Major Accident and/or Disaster with Soil, Water and Biodiversity

Construction and Operational Phase

The vulnerability of the proposed road development to risks associated with major accidents and/or disasters and potential interactions with soil, water and biodiversity was also assessed. A number of events were identified (Refer to **Table 19.1** above) such as major traffic collision (as described previously), hydrological and hydrogeological, structural collapse events, tunnel fire events, service utility events and ground collapse events. As above, although, the consequence of these events is 'very serious', potentially resulting in pollution of water or contamination of soil with the consequential impacts on biodiversity or direct impacts on biodiversity as a result of ground collapse, the likelihood is considered to be low. The potential for low likelihood but potentially high consequence major accident and/or disaster events remains, although the possibility is extremely remote. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence events. Refer to **Section 19.2** above for further details.

19.4.2.30 Interaction of Risks of Major Accident and/or Disaster with Material Assets

Construction and Operational Phase

The vulnerability of the proposed road development to risks associated with major accidents and/or disasters and potential interactions with material assets was also assessed. A number of events were identified (Refer to **Table 19.1** above) such as major traffic collision (as described previously), hydrological and hydrogeological, structural collapse events, tunnel fire events, service utility events and ground collapse events. As above, although, the consequence of these events is 'very serious', potentially resulting in impacts to properties, the likelihood is considered to be low. The potential for low likelihood but potentially high consequence major accident and/or disaster events remains, although the possibility is extremely remote. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence events. Refer to **Section 19.2** above for further details.

19.4.3 Summary

All of the potential impacts arising from the potential interactions were identified at a very early stage in the design process and in the EIAR preparation. They were therefore addressed in the design of the proposed road development and in the baseline and impact assessment studies. As a result, the potential impacts were either avoided altogether through design measures or they were addressed through specific mitigation measures. This early identification process helped to identify and minimise the potential for significant interactions of impacts arising. The assessment presented above of the interactions of the potential impacts did not identify the need for any additional mitigation measures.

19.5 Cumulative Impacts

19.5.1 Introduction

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects could cumulatively result in a likely significant environmental impact. Cumulative impacts arising from the interaction between the proposed road development and other projects for each of the environmental factors have been identified and addressed in detail in the respective chapters. The results of these cumulative assessments are also summarised below.

Cumulative impacts are defined as the combination of many minor impacts creating one larger, more significant impact (NRA, 2009 and EPA 2017). Cumulative impacts consider existing stresses on the natural environment as well as developments that are underway and in planning.

Following a review of the committed projects and the planning files for Galway City and County Council, the following projects and plans which are either in place, or proposed, were considered to have the potential for cumulative impacts to increase the significance of the impacts predicted for the proposed road development are listed below:

- The planning registers for Galway City and County Council
- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- M6 (M17/M18) Motorway Service Area (pre-planning)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)

- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS), which includes the following:
  - Investigation of prospective sites to the east of the city for Park and Ride
  - Bearna Greenway
  - Galway to Oughterard (part of the Galway to Clifden) Greenway
  - Galway City to Oranmore (part of the Galway to Dublin) Cycleway
- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021
- Bearna Local Area Plan 2007–2017
- Gaeltacht Local Area Plan 2008–2018
- Údarás na Gaeltachta's Strategic Plan 2014–2017
- Ardaun Local Area Plan 2018–2024

19.5.2 Human Beings, Population and Human Health

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on human beings, population and human health.

Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed in relation to human beings, population and health as they have the potential for cumulative impacts in respect to this environmental topic:

- The planning registers for Galway City and County Council
- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- M6 (M17/M18) Motorway Service Area (pre-planning)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS), which includes the following:
  - Investigation of prospective sites to the east of the city for Park and Ride
  - Bearna Greenway
  - Galway to Oughterard (part of the Galway to Clifden) Greenway
  - Galway City to Oranmore (part of the Galway to Dublin) Cycleway

- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021
- Bearna Local Area Plan 2007–2017
- Gaeltacht Local Area Plan 2008–2018
- Údarás na Gaeltachta's Strategic Plan 2014–2017
- Ardaun Local Area Plan 2018–2024

19.5.2.1 Socio-Economics

The proposed road development will improve accessibility both within and to/from Galway City and connectivity between Galway City and areas outside of the city including Connemara, the East and North West of Ireland. As a result, there are significant potential positive impacts which will benefit economic and regional development, including tourism. The proposed road development will have a positive cumulative socio-economic impact with the proposed roads projects listed above and with the Galway Harbour Project.

The proposed road development could also stimulate new physical commercial or tourism development. These developments would be subject to planning assessment given the objectives set out in the Galway City and Galway County Development Plans to consolidate development and to provide for balanced sustainable development. They will also be subject to Appropriate Assessment to avoid any adverse impacts on sensitive landscapes and natural habitats. These considerations apply also to the largely rural area surrounding the city, noting that the proposed road development will be used for a proportion of commuting journeys as well as for regional journeys. The transfer of some of these journeys to the proposed road development away from the existing N6 is a significant positive impact, but any cumulative impacts on settlement patterns will be monitored and addressed in future development and local area plans.

The proposed road development will facilitate the full implementation of the GTS and to provide for improved public transport and facilities for pedestrians and cyclists. For example, the reduced volume of traffic on the existing N6 will present an opportunity to greatly improve the continuity of cycle lanes, including at junctions, and to add more pedestrian crossings, while minimising impacts on traffic flow. Once implemented, all these measures will have a very significant impact on safety and the journey amenity of pedestrians and cyclists, and on general environmental quality if this contributes to a modal transfer from vehicles.

In summary the cumulative impacts of the projects and plans listed above in association with the proposed road development are positive.

19.5.2.2 Irish Language

Having considered the proposed road development in tandem with other relevant plans or projects identified above, it is considered that no significant negative cumulative impact upon the status of Irish as a community language will occur.

19.5.2.3 Human Health

It is not considered that there will be any negative cumulative effects on human health. The distances between the projects noted above and the proposed road development results in no cumulative noise or air quality impacts. There is potential that reduced journey times and fewer unforeseen delays could have a potential benefit on psychological health. Any projects which make roads safer and reduce the probability of road accidents and fatalities can only be seen in positive terms from a human health perspective. The cumulative health benefits of the proposed road development with the GTS are further assessed below.

Quantification of cumulative health benefits with the GTS

The cumulative health benefits of the proposed road development with the GTS were assessed by using the Western Regional Model to quantitatively measure some of the health, accessibility and social inclusion[15] impacts once the proposed road development and the GTS were fully implemented.

<u>Physical Activity Analysis</u>

The assessment indicates that the total number of people cycling, over a 24-hour period in Galway City, will increase by approximately 21% as a result of the implementation of the GTS and associated cycling infrastructure improvements. This increase in cyclists will result in a reduced risk of premature deaths for those who are new to cycling and currently exercise infrequently. By comparison, results from the assessment indicate that pedestrian trips (trips which use walking only to get from origin to destination) in Galway City are expected to decrease marginally (less than 1% reduction) across the full 24-hour period. The reduction in pedestrian activity in Galway City is mostly as a result of people transferring to cycling or using the improved public transport services implemented as part of the Galway Transport Strategy.

<u>Accessibility Analysis</u>

The changes in accessibility for key locations were determined on a zone by zone basis. This was undertaken using a visual representation of the changes in journey times between the ‘Do-Nothing’ and ‘Do-Something’ Scenarios for cycling, public transport and private car. The results of this assessment showed that in general, most zones experience a decrease in car journey times. There are however, a small number of zones, mostly in the city centre, which are expected to experience an increase in car journey times to access key sites. This is as a result of the public transport priority measures, such as private vehicle restrictions on Salmon Weir Bridge, which make accessing these areas by car more difficult. In general, most zones also experience a decrease in public transport journey times. There are however, a small number of zones which are expected to experience an increase in public transport journey times as they will not be served as directly by public

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[15] It should be noted that this analysis represents an assessment of those elements of Health, Accessibility and Social inclusion which can be measured using model outputs from the WRM. As such, these outputs are not representative of all the benefits/disbenefits which result from the implementation of the GTS under these categories.

transport once the changes in bus routes proposed as part of the GTS are implemented.

Social Inclusion Analysis

Outputs from the traffic model have also been used to assess the impacts of the Galway Transport Strategy in terms of Social Inclusion. For this assessment, the outputs from the economic module (produced using the software Tuba) were used to visually identify which locations would benefit or suffer disbenefits as a result of the GTS. The benefits in this instance are measured in terms of journey time saving. These benefits/disbenefits were then compared against the deprivation index for the same locations to assess how the benefits of the proposed road development are distributed among affluent and less affluent areas. The results of this assessment showed that most zones will experience an improvement in journey times for all trips from those zones. Some city centre zones however, will experience increase in journey times by car following the implementation of the GTS measures. This is a result of public transport priority measures and public realm enhancements in the city centre which will increase travel time for some car trips into and around the city centre. With respect to public transport, a small number of zones are seen to experience marginal disbenefits as a result of bus route changes which give these zones less direct access to the public transport network. Comparison of these benefits with the deprivation index show that, in general, the benefits of the proposed road development are distributed evenly between disadvantaged and more affluent areas and no disbenefits were experienced in the most disadvantaged areas.

19.5.3 Material Assets – Non Agriculture

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on material assets – non agriculture.

Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed in relation to material assets non-agriculture:

- The planning registers for Galway City and County Council
- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS), which includes the following:
    - Investigation of prospective sites to the east of the city for Park and Ride

- Bearna Greenway
- Galway to Oughterard (part of the Galway to Clifden) Greenway
- Galway City to Oranmore (part of the Galway to Dublin) Cycleway

Although the proposed road development overlaps with other proposed projects such as the GTS measures, none of the projects or plans have been identified that will result in a significant negative cumulative impact with the addition of the proposed road development upon material assets non-agriculture.

19.5.4 Material Assets – Agriculture

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on agriculture.

Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed in relation to material assets agriculture:

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- M6 (M17/M18) Motorway Service Area (pre-planning)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Transport Strategy (GTS), which includes the following:
  - Investigation of prospective sites to the east of the city for Park and Ride
  - Bearna Greenway
  - Galway to Oughterard (part of the Galway to Clifden) Greenway
  - Galway City to Oranmore (part of the Galway to Dublin) Cycleway

The cumulative impact on regional agriculture is appraised by assessing the impact on agriculture in County Galway due to the landtake for the proposed road development in combination with other recently constructed and planned roads (M6, N83/N18, N59 Maam Cross to Oughterard and Moycullen Bypass). These recently constructed and planned roads in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends[16] the cumulative impact on agriculture in County Galway is not significant.

There are cumulative impacts from the built M6 Motorway Scheme on four individual land parcels at the eastern end of the proposed road development. While there are significant cumulative impacts individually on these four[17] land parcels

[16] From 2010 – 2016 cattle numbers and sheep numbers increased 7% and 25% respectively – source CSO Table AAA08 and DAFM website.

[17] MO 751, MO 752, MO 754, and MO 758.

within the study area, the overall cumulative impacts on agriculture is not significant.

19.5.5 Air Quality and Climate

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on air quality and climate.

Of the projects and plans listed in **Section 19.5.1** the following have been assessed in relation to air quality and climate:

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Transport Strategy (GTS), which includes the following:
  - Investigation of prospective sites to the east of the city for Park and Ride
  - Bearna Greenway
  - Galway to Oughterard (part of the Galway to Clifden) Greenway
  - Galway City to Oranmore (part of the Galway to Dublin) Cycleway

The traffic data used in the assessment for future years, considers development proposed for the Galway area as listed above and incorporates the cumulative impacts of these projects into the do-minimum traffic data used in this EIAR. No major construction works are envisaged to take place in such proximity to the proposed road development which would significantly impact on dust levels. The cumulative impacts are considered by incorporating background concentrations into predicted values and existing traffic volumes. Negative significant cumulative impacts on air quality will not arise.

The main objective of the GTS is to address the current and future transport requirements of Galway City and its environs. This includes the provision of new transport infrastructure. The proposed road development has been assessed with reference to the of the Galway Transport Strategy measures. Negative significant cumulative impacts on air quality will not arise.

19.5.6 Noise and Vibration

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on noise and vibration.

Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed for cumulative impacts in relation to noise and vibration:

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Transport Strategy (GTS), which includes the following:
    - Investigation of prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway

The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of other committed plans and projects listed above which have the potential to generate traffic volumes within the study area. Further details on the traffic modelling forecasts are set out in **Chapter 6, Traffic Assessment and Route Cross Section**.

The cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. During the Do-Nothing scenario, road traffic flows along the existing road network have been modelled and the cumulative traffic noise level calculated. For the modelled Do-Something scenarios, road traffic along the existing road network coupled with traffic along the proposed road development are combined to obtain a cumulative traffic noise level. The assessment takes account of any alignment alterations to the existing roads and junctions and the re-distribution of traffic along the existing road network as a result of the proposed road development.

In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Table 17.13** and **Table 17.15** of **Chapter 17, Noise and Vibration**.

In relation to cumulative construction impacts, other committed significant construction projects have been reviewed in the vicinity of Galway City and County including the N59 Maam Cross to Oughterard Road Project (consented and pre-construction), N59 Moycullen Bypass (consented and pre-construction) and M6(M17/M18) Motorway Service Area (pre-planning). All of these projects are set back at considerably distances from the proposed road development such that if under construction at the same time, no cumulative noise and vibration impacts would occur.

Whilst there is the potential to be other small local construction activities across the study area during the construction phase, for the purposes of this assessment it has been assumed that works associated with the proposed road development will be the dominant noise and vibration source at any one location.

19.5.7 Landscape and Visual

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant landscape and/or visual effect. The projects and plans listed in **Section 19.5.1** were assessed in relation to landscape and visual.

The construction and operational stages of the proposed road development give rise to significant, very significant and profound landscape and visual impacts. These impacts are generally focused within the immediate corridor of the proposed road development on the urban/rural edge of the city. To the west and north of the city much of the lands along the corridor are identified for agricultural and/or amenity uses. Further sports and amenity developments are likely within the grounds of NUIG Sporting Campus on the west bank of the River Corrib. While there are some small areas of residential zoning at Ballymoneen, Rahoon, Letteragh, Ballindooley and Castlegar, development in these areas is unlikely to give rise to significant landscape and visual impacts or cumulative impacts. An area of enterprise, industrial and related zoning is indicated to the north and east of Galway Racecourse, but much of these lands are already developed within Parkmore Business Park.

The eastern end of the proposed road development falls within the area covered by the Draft Arduan Local Area Plan (LAP) 2017. This Draft LAP proposes major development in the area, including new residential and commercial developments on c.81 hectares of an overall LAP area of c.164 hectares on the east side of the city. The existing M6/N6 corridor runs through the centre of the Draft LAP area and the proposed road development ties-in to the existing road infrastructure within the Draft LAP area. While the Draft LAP envisages significant changes to the landscape and visual setting of the area, it is likely that the measures proposed will be delivered on a phased basis over a long period of time. Nevertheless, depending on timing of delivery, scope exists for some limited or nonsignificant cumulative landscape and visual impacts to arise.

The Galway Transport Strategy (GTS) also envisages further transport-related developments, including public transport and cycleway and greenway measures. However, these measures are unlikely to further adversely impact the landscape or visual setting along the proposed road development.

The Galway Harbour Port Extension project is at planning stage. However, if permitted, it is not expected that any significant cumulative landscape or visual effects will arise because of the separation distance between the proposed road development and the port location.

Other projects, such as the M17 Galway to Tuam Road Project (operational); the N18 Oranmore to Gort Road Project (operational); the N17 Tuam Bypass (operational); the M6 Motorway (operational); M6(M17/M18) Motorway Service Area (pre-planning); the N59 Maam Cross to Oughterard Road Project (consented and pre-construction); and the N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction), are considered too distant from the proposed road development to give rise to cumulative landscape and/or visual effects.

In summary it is considered that there is limited potential for any significant cumulative impacts with other planned or potential developments and that these will not further increase the adverse or negative impacts associated with the proposed road development.

19.5.8 Archaeological, Architectural and Cultural Heritage

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on archaeological, architectural and cultural heritage. Of the list of projects and plans listed in **Section 19.5.1** the cumulative impacts of the proposed road development on archaeology, architecture and cultural heritage with the following projects and plans have been assessed:

- N59 Maam Cross to Oughterard Road Project
- M17 Galway to Tuam Road Project
- N18 Oranmore to Gort Road Project
- N17 Tuam Bypass
- M6 Motorway
- Proposed Galway Harbour Port Extension
- Galway Transport Strategy (GTS), which includes the following:
    - Investigate prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway
- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021

No proposed developments have been identified that will result in a significant negative cumulative impact with the addition of the proposed road development upon the archaeological, architectural and cultural heritage resource.

The proposed Galway to Oughterard (part of the Galway to Clifden) Greenway will see the reopening of the railway line and potentially the repair of railway heritage features. The proposed road development will impact on a portion of the original railway line route where it passes through Dangan Lower. Sections of the railway line have been removed over the years due to differing activities, meaning that the proposed road development will result in a slight negative cumulative impact on the route of the original railway line. The proposed Galway to Oughterard Greenway scheme will have a positive impact on the cultural heritage of the area, which will help to offset the potential negative cumulative impact associated with the proposed road development. No negative residual impacts have been identified in association with the route of the former railway.

19.5.9 Soils and Geology

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on soils and geology. Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed for cumulative impacts with respect to soils and geology:

- The N59 Oughterard to Maam Cross
- M17/N18 Gort to Tuam PPP Scheme
- Galway Harbour Port Extension
- Galway Transport Strategy (GTS), which includes the following:
    - Investigate prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Tuam Road Bus Corridor Scheme
    - Expansion of Public Bike Hire Scheme
- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021

Cumulative soils and geology impacts can occur when other projects in the locality have similar soils and geology potential impacts as the proposed road development. Cumulative impacts are assessed based on the residual impact of these impacts on the proposed projects.

The following feature/construction activity impacts are identified in some of the projects and plans, listed above, and are also present in the proposed road development:

- Peat Removal/Disposal
- Impact to Geological Heritage Sites
- Contaminated Ground
- Loss of agricultural land and solid geology
- Haulage of material

As part of the environmental evaluation of the proposed road development the residual impact from peat removal/disposal, geological heritage sites and contaminated ground is imperceptible. Due to the mitigation measures considered in the other projects, the residual impact of those projects is also considered imperceptible. Therefore, the cumulative impact of these impacts is imperceptible.

The cumulative impact for:

- peat removal/disposal is considered to be imperceptible as peat is intended to remain within the proposed development boundary for each respective project

- geological heritage sites is considered to be imperceptible as none of the projects indicate that geological heritage sites or county geological sites will be impacted. The Galway Transport Strategy specifically outlines that it will seek to protect such sites from any inappropriate measures
- contaminated ground is considered to be imperceptible as the Galway City Development Plan (2017-23) waste management policy contains policy to ensure that proposals on contaminated lands include appropriate remediation measures

Loss of agricultural land and solid geology and haulage of material, whether imported or sourced from site, are activities that are also considered on other projects. Mitigation measures for other projects include the reduction and minimisation of removal or disposal of material off-site and the reuse of such material whether in construction fill or in designated material deposition areas. Consideration has been given to the extent of material which will be imported, exported or disposed and their combined impact. The cumulative impact is considered to remain unchanged as the combination of the impact will not increase the magnitude of the impact from small adverse.

The significance of the impact of the proposed road development operational activities is imperceptible and is considered not to change in combination with the other projects.

Therefore, there are no other plans or projects that are likely to result in a significant effect on soils and geology cumulatively with the proposed road development.

19.5.10 Hydrogeology

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on hydrogeology.

Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed for cumulative impacts with respect to hydrogeology:

- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS)

The hydrogeological baseline has identified that the groundwater bodies in the study area have a number of existing stresses in the form of discharges from wastewater treatment systems, septic tanks, road runoff, quarrying and agriculture. These potential pollutant sources have the potential to impact the groundwater environment in the form of reducing water quality by increased contaminants. On the basis of the design and mitigation measures employed for the proposed road development to accommodate and maintain the existing groundwater body (GWB) sub-catchments there will be no alteration of groundwater pathways that could modify the impacts from existing pollutant sources.

The zone of influence from the N59 Maam Cross to Oughterard Road Project and N83/N18 projects occurs within separate groundwater sub catchments to those identified for the proposed road development and as such any impacts from these projects will not impact on the groundwater systems that the proposed road development straddles.

The proposed Galway Harbour Port Extension is located within the same GWB sub-catchment as the proposed road development but is located significantly downgradient of the proposed road development in transition coastal waters.

The Galway Transport Strategy includes some realignment of local roads but these do not incorporate cuttings or structures that could impact on groundwater.

The cumulative impact of the proposed road development with existing stresses on the hydrogeological environment and those in development or in planning has been considered. On the basis of the design and mitigation measures employed for the proposed road development there will be no alteration of groundwater pathways and hence no enhanced impact from existing pollutant sources within groundwater bodies. Furthermore, those new developments being constructed or proposed are located in different GWB sub catchments or located significantly downgradient so as not to cumulate impacts.

On this basis the cumulative impacts of the above projects with the proposed road development is imperceptible.

19.5.11 Hydrology

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on hydrology. Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed for cumulative impacts with respect to hydrology:

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Proposed Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS)
- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021

The hydrological baseline has identified that the surface water features in the study area have a number of existing stresses in the form of discharges from surface water drainage systems, road runoff and agricultural activities and loss of natural flood plains. These sources have the potential to impact the existing hydrological environment in the form of reducing water quality by increased contaminants or by increasing flood risk. On the basis that the design and mitigation measures employed for the proposed road development will maintain or improve water quality in existing catchments, there are no significant hydrological residual impacts associated with the proposed road development.

The Galway County Development Plan 2015-2021 and Galway City Development Plan 2017-2023 set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and restricting surface water runoff discharge rates to meet that of greenfield runoff rates and volumes. Therefore, the residual impact associated with future proposed or planned developments on the hydrological environment is imperceptible.

The M17/M18 Tuam to Gort Motorway Project has recently completed construction. The portion of the M17 and Tuam Bypass (circa 26km) that lies north of the existing R339 Galway to Caltra Road, lies within the catchment of the River Corrib. The portion of the M17/M18 to the south of the R339 lies within the catchment of Galway Bay for the Oranmore River, Clarin River, Kilcolgan River, Gort River and Lough Coole turlough system. This M17/M18 scheme has been designed with a modern road drainage system and construction methods that reduce the potential impact on the receiving environment. Where residual local impacts arise at various road outfalls, culvert crossings and displacement of flood storage, cumulative impacts do not arise downstream in the River Corrib or to Galway Bay given the very large dilution available and the travel distances involved.

There will be no perceptible hydrological cumulative impact between the M17/M18 Tuam to Gort Motorway Scheme and the proposed road development.

The N59 Maam Cross to Oughterard Road Project and N59 Maigh Cuilinn (Moycullen) Bypass Road Project also lie within the catchment of the River Corrib upstream of the proposed road development. Both N59 road schemes have been designed with modern road drainage systems and construction methods that reduce the potential impact on the receiving environment. Where local impacts arise at various road outfalls and culvert crossings and displacement of flood storage and changes to river and stream morphology, these impacts do not translate downstream in the River Corrib (given the very large dilution available and the travel distances involved) as perceptible impacts that would combine with residual impacts from the proposed road development. There will be no perceptible hydrological cumulative impact between the N59 Maam Cross to Oughterard to Road Project and the N59 Maigh Cuilinn (Moycullen) Bypass Road Project with the proposed road development.

The proposed Galway Harbour Port Extension is located in the Galway City Coastal catchment and at the mouth of the River Corrib Estuary downstream of the proposed road development. Hydrological residual impacts have been identified in the Galway Harbour Company, Galway Harbour Extension Environmental Impact Statement and include potential changes in salinity levels, current velocities and current directions, pollution risks during construction, maintenance dredging impacts and changes in wave climate.

The proposed road development will have no noticeable effect on the flow regime, salinity, sedimentation process or water quality downstream in the River Corrib Estuary and Inner Galway Bay, both during construction and operation stages. Therefore, no cumulative hydrological impacts will occur between the proposed Galway Harbour Port Extension and the proposed road development, even if the construction phases for both projects were to coincide.

There are a number of elements of the Galway Transport Strategy (GTS) located within the same hydrological catchments as the proposed road development. The relevant elements of the GTS that could have an impact on hydrology include:

- The upgrading of pedestrian network
- The upgrading of cycle network which includes the Bearna Greenway, the Galway to Dublin Cycleway (Galway City to Oranmore)[18], the Galway to Oughterard Greenway[19] and non-greenway elements
- Expansion of Public Bike Hire Scheme (currently under construction)
- The upgrading of public transport network including increased frequency of buses and a new cross city access link (including the N17 Tuam Bus Corridor Scheme)
- The upgrading of road network which includes modifications to the existing road infrastructure and the proposed road development

The GTS is at the plan stage so each individual measure will be subject to further detail design. The detailed design shall be in compliance with the surface water management and water quality objectives set out in the various development plans. Therefore, there will be no negative cumulative impacts associated with this development.

19.5.12 Biodiversity

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on biodiversity.

[18] The GTS includes that portion of the Galway to Dublin Cycleway between Galway City and Oranmore.

[19] The GTS includes that portion of the Galway to Oughterard Greenway between Galway City and Moycullen.

All of the projects and plans listed in **Section 19.5.1** have been assessed for cumulative impacts with respect to biodiversity. In addition, the following projects were also considered in the assessment:

- Sáilín to Silverstrand Coastal Protection Scheme
- Salthill Coastal Protection Works (Blackrock to Galway Golf Club)

The potential for other plans or projects to act cumulatively with the proposed road development to adversely affect the integrity of any European sites, is considered in Section 12 of the NIS (termed "in combination effects" in the context of the NIS assessment). The four European sites within the ZoI of the proposed road development are Lough Corrib cSAC, Galway Bay Complex cSAC, Lough Corrib SPA and Inner Galway Bay SPA. There is no potential for any other plans or projects to act in combination with the proposed road development to adversely affect the integrity of any other European sites, as they are beyond the ZoI of the proposed road development.

The assessment identified those plans and projects which have the potential to impact on Lough Corrib cSAC, Galway Bay Complex cSAC, Lough Corrib SPA and Inner Galway Bay SPA and assessed whether they had the potential to adversely affect the integrity of these European sites. Any plan or proposed project that could potentially affect these European sites in combination with the proposed road development must adhere to the overarching policies and objectives of the relevant land use plan(s), as dependent on the location of the specific plan or proposed project. These are the *Galway County Development Plan 2015-2021*, the *Galway City Council Development Plan 2017-2023*, the *Clare County Development Plan 2017-2022* and the *Mayo County Development Plan 2014-2020*. The protective policies and objectives in these land use plans will ensure the protection of European sites across the identified potential impact pathways.

As the proposed road development will not affect the integrity of Lough Corrib cSAC, Galway Bay Complex cSAC, Lough Corrib SPA or Inner Galway Bay SPA, and given the protection afforded to European sites under the overarching land use plans, it was concluded that there is no potential for adverse effects on the integrity of any European sites to arise as a consequence of the proposed road development acting in combination (or cumulatively) with any other plans or projects.

The potential for cumulative impacts to arise are limited to those residual impacts associated with the proposed road development and those effects the proposed road development will have on the receiving environment that are measurable in some way, but themselves will not result in a likely significant residual effect on biodiversity.

The residual impacts associated with the proposed road development relate to the following and are discussed in the sections below:

- Habitat loss, including both the permanent loss of Annex I habitats and habitats valued as being of local importance
- The potential loss of a Peregrine falcon nest site due to long-term disturbance/displacement impacts

- Impacts on bats as a result of the construction and operation of the proposed road development

The other impacts associated with the proposed road development that are measurable in some way, but themselves will not result in a likely significant effect on biodiversity are impacts on the existing hydrological and hydrogeological regimes, impacts on air quality and impacts to species as a result of disturbance or displacement. The land use zonings and environmental protection objectives that relate to this area are contained in the *Bearna Local Area Plan 2007-2017, Galway County Development Plan 2015-2021* and the *Galway City Council Development Plan 2017-2023*. There are also environmental protective policies and objectives in both the *Galway City Council Development Plan 2017*-2023 and the overarching *Galway County Development Plan 2015-2021*, and in River Basin Management Plan for Ireland (2018-2021) (draft for public consultation) for the area. The *Ardaun Local Area Plan 2018–2024* is subject to the protective policies and objectives in the *Galway City Council Development Plan 2017*-2023. The *Gaeltacht Local Area Plan 2008–2018* and the *Údarás na Gaeltachta's Strategic Plan 2014–2017*, in so far as they could interact cumulatively with the proposed road development given their spatial coverage, are subject to the protective policies and objectives in the *Galway County Development Plan 2015-2021* and the *Galway City Council Development Plan 2017*-2023.

Given the zonings and objectives that are in place in these plans, it is considered that there are no other plans or projects that are likely to result in a significant effect on biodiversity, cumulatively with the proposed road development, as a consequence of impacts on surface water and groundwater air quality and disturbance or displacement impacts.

19.5.12.1 Impacts from habitat loss

As outlined in **Section 8.4.2** of **Chapter 8, Biodiversity** habitat loss to development and land use change has been an ongoing impact locally which may have already had effects on local biodiversity. Those projects listed above in **Section 19.5.1** have, or are likely to, result in habitat impacts (including those of a high biodiversity value such as Annex I habitat types) which may also have knock-on effects on fauna species. Therefore, land use change and habitat losses are likely to continue to some degree and the loss and fragmentation of habitat associated with the proposed road development will contribute to this trend locally.

Habitat losses, regardless of their own habitat value, also have the potential to have an effect on the local fauna populations that they support. The most significant impact in that regard are the likely effects of habitat loss on the local bat populations; particularly the Menlo Castle Lesser horseshoe bat population (impacts on bats are discussed separately below).

The losses of areas of Annex I habitat associated with the proposed road development are considered to be at the highest level of geographic significance for the habitats involved. In addition, the proposed road development will be contributing to an existing trend of Annex I habitat loss locally. While the cumulative effect of habitat losses, would increase the magnitude of the impact, it does not increase the geographic scale of the impact significance associated with the proposed road development.

In relation to areas of locally important habitats that will be lost, given the habitat types involved and that at any greater geographic scale they are likely to remain in a favourable conservation condition, any cumulative losses of these habitat types are not likely to increase the impact significance.

The protective polices in the *Bearna Local Area Plan 2007-2017*, the *Galway City Council Development Plan 2017-2023* and the *Galway County Development Plan 2015-2021* to protect biodiversity will moderate any future impacts on biodiversity, including those related to Annex I habitat types. Where the losses can be compensated[20] for (see **Section 8.8** of **Chapter 8, Biodiversity**), this offsets the contribution of the proposed road development to existing losses of the habitat type in question whilst ensuring that there is no potential for other developments to result in a significant cumulative impact.

19.5.12.2 Impacts on Peregrine falcon

Peregrine falcon is an Annex I species but is not listed as a Special Conservation Interest (SCI) species for its breeding population in any SPAs within the ZoI of the proposed road development (the closest SPA with Peregrine falcon as an SCI is in Sligo). It is also on the Green BoCCI (breeding)[21] List. Birds on the Green list are considered to be those of least conservation concern in Ireland. The local Peregrine falcon population are valued as being of county importance as the local area supports more than 1% of the known nesting sites across counties Galway and Clare.

Due to the potential for long-term disturbance and displacement of the Lackagh Quarry Peregrine falcon pair from the existing nest site, the proposed road development is likely to result in a significant negative residual effect on Peregrine falcon, at the county geographic scale.

The two other Peregrine falcon nest sites that are present locally are likely to continue to support breeding Peregrine falcon. One site is an inactive quarry which is zoned for agricultural use and is therefore, not likely to see any increased disturbance from development; the second nest site is a regularly occupied site in an active quarry and the baseline levels of disturbance, to which the resident Peregrine pair are habituated, are likely to remain. Neither of these sites are likely to be affected by any of the projects listed above, given their locations relative to where those strategies/projects will be implemented. Existing pressures at the county level on suitable nest site availability are expected to continue and may act cumulatively at the county geographic scale, but there is not sufficient data available to quantify this. However, any additional pressures on the Peregrine falcon population will not increase the overall significance of the impact of the

[20] These are not compensatory measures in the context of the requirements of Article 6(4) of the Habitats Directive as they are not compensating for an impact that would adversely affect the integrity of any European site. As concluded in the NIS, the proposed road development will not result in such an impact on any European site

[21] Birds of Conservation Concern in Ireland (BoCCI) after Colhoun & Cummins, 2013

proposed road development to a national level impact given that the species is currently considered to be of a low conservation concern for its national population.

Therefore, there are no other projects that are likely to cumulatively act along with the proposed road development to increase the predicted impact significance of the proposed road development on Peregrine falcon from the likely significant negative residual effect, at the county geographic scale.

19.5.12.3 Impacts on bats

The predicted residual impacts on bats include loss of roosts, loss of foraging habitat and the barrier/severance effect posed by roads.

Some proportion of existing roost sites in the vicinity of the proposed road development may deteriorate over time and become unsuitable for bats to use (e.g. derelict structures and old trees). Therefore, the roost sites that will be affected by the proposed road development could potentially contribute to natural declines in other roost sites locally.

Loss of foraging habitat and barriers to bat movements may result from development of zoned land within the northern fringes of Galway City. Lands used by bats which are also zoned for development include light industrial zoning (C2.1) near the N84 Headford Road and Ballindooley, which may affect the proposed artificial roost via increased light spill. The recreation and amenity zoning at NUIG may also interact with the flight paths of bats moving between the Aughnacurra roosts and Menlo Castle and the use of those lands by foraging bats (e.g. where additional lighting may be proposed in the future). However, all of these impacts would be controlled by the assessment of individual planning applications which would consider the effects on protected species such as bats as part of their appraisal by the competent authority, having regard to the protective environmental policies outlines in the *Bearna Local Area Plan 2007-2017*, the *Galway City Council Development Plan 2017-2023* and the *Galway County Development Plan 2015-2021* and the Ardaun Local Area Plan 2018-2024 [22] to protect biodiversity. Therefore, there are no additional cumulative impacts predicted regarding loss of foraging habitat or from barriers to bat movement.

19.5.13 Overall Cumulative Impact Assessment

The individual cumulative assessments for each environmental factor of each of the projects and plans have been considered above. No additional mitigation measures are required for any cumulative effects of the proposed road development with other projects and plans. Each of the projects and plans listed in **Section 19.5.1** as a whole have also been considered with the proposed road development and the assessment is presented below in **Table 19.3**. No additional cumulative impacts other than those already identified in the individual assessments will arise.

[22] Although a draft plan at the time of writing, it is included as it is likely to be adopted in 2018.

Table 19.3: Overall Cumulative Impact Assessment

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
M17 Galway to Tuam Road Project (operational)	**Socio Economic:** Overall there will a positive cumulative impact in terms of connectivity between Connemara, Galway City and the rest of Ireland.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends[23] the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. This project is complete and therefore there will be no additional cumulative increase in air quality pollutant levels. The cumulative impacts are considered by adding background concentrations to predicted concentrations. There will be no significant cumulative impacts on air quality.	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration**.	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	

[23] From 2010 – 2016 cattle numbers and sheep numbers increased 7% and 25% respectively – source CSO Table AAA08 and DAFM website.

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within a different groundwater body sub catchment to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	
	Biodiversity: As the drainage for this project will ultimately discharge to the River Corrib and Galway Bay, there is the potential for cumulative effects on water quality in the River Corrib and in Galway Bay. Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for the project, the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	
N18 Oranmore to Gort Road Project (operational)	**Socio Economic:** Overall there will be a positive cumulative impact in terms of connectivity between West County Galway, Galway City and the rest of Ireland.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends from 2010 to 2016 the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. This project is complete and therefore there will be no additional cumulative	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	increase in air quality pollutant levels. The cumulative impacts are considered by adding background concentrations to predicted concentrations. There will be no significant cumulative impacts on air quality.	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration**.	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no negative significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within a different groundwater body sub catchment to the proposed road development and therefore there will be no significant negative cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no negative significant cumulative impacts	
	Biodiversity: As the drainage for this project will ultimately discharge to the River Corrib and Galway Bay, there is the potential for cumulative effects on water quality in the River Corrib and in Galway Bay. Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for the project, the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	
N17 Tuam Bypass (operational)	**Socio Economic:** Overall there will be a positive cumulative impact in terms of connectivity between West County Galway, Galway City and the rest of Ireland.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. This project is complete and therefore there will be no additional cumulative increase in air quality pollutant levels. The cumulative impacts are considered by adding background concentrations to predicted concentrations. There will be no significant cumulative impacts on air quality.	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration**.	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within a different groundwater body sub catchment to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Biodiversity: As the drainage for this project will ultimately discharge to the River Corrib and Galway Bay, there is the potential for cumulative effects on water quality in the River Corrib and in Galway Bay. Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for the project, the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	
M6 Motorway (operational)	**Socio Economic:** Overall there will be a positive cumulative impact in terms of connectivity between West County Galway, Galway City and the rest of Ireland	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. This project is complete and therefore there will be no additional cumulative increase in air quality pollutant levels. The cumulative impacts are considered by adding background concentrations to predicted concentrations. There will be no significant cumulative impacts on air quality.	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration**.	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within a different groundwater body sub catchment to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	
	Biodiversity: Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for tthis project, and the environmental protection policies included within the *Galway County Development Plan 2015-2021*, and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	
M6 (M17/M18) Motorway Service Area (pre-planning)	**Socio Economic:** Overall there will be a positive cumulative impact for users of the M6 and the proposed road development given demand for services on these roads.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: Given the distance between the proposed road development and this project there will be no significant cumulative impacts during the construction phase.	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Noise and Vibration: Given the distance between the proposed road development and this project there will be no significant cumulative impacts during the construction phase	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	
	Soils and Geology: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
	Hydrogeology: The zone of influence for this project is within a different groundwater body sub catchment to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	
	Biodiversity: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
N59 Maam Cross to Oughterard Road Project (consented and pre-construction)	**Socio Economic:** Overall there will a positive cumulative impact in terms of connectivity between Connemara, Galway City and the rest of Ireland.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends the cumulative impact on agriculture in County Galway is not significant.	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. Given the distance between the proposed road development and this project there will be no significant cumulative impacts during the construction phase. .	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration.**	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within a different groundwater body to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	
	Biodiversity: Any impacts on habitats or bats associated with this project will not affect the significance of the residual impacts associated with the proposed road development. As a project which lies within the River Corrib catchment, there is the potential for cumulative effects on water quality in the River Corrib and Galway Bay. Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for the project, the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)	**Socio Economic:** Overall there will be a positive cumulative impact in terms of connectivity between Connemara, Galway City and the rest of Ireland.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. Given the distance between the proposed road development and this project there will be no significant cumulative impacts during the construction phase.	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration**.	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no significant cumulative impacts	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Hydrogeology: The zone of influence for this project is within a different groundwater body to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	
	Biodiversity: Any impacts on habitats or bats associated with this project will not affect the significance of the residual impacts associated with the proposed road development. As a project which lies within the River Corrib catchment, there is the potential for cumulative effects on water quality in the River Corrib and Galway Bay. Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for the project, the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	
Galway Harbour Port Extension (planning stage)	**Socio Economic:** Overall there will be a positive cumulative impact on the economy of Galway City	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: There is no overlap between the proposed road development and this project and therefore there will be no significant cumulative impacts	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Given the distance between the proposed road development and this project there will be no significant cumulative impacts during the construction phase.	
	Noise and Vibration: Galway Harbour Port Extension is set back a considerably distance from the proposed road development such that if under construction at the same time, no cumulative noise and vibration impacts would occur.	
	Landscape and Visual: Given the separation between the proposed road development and the port it is not expected that there will be any significant cumulative impacts	

Plan/Project	**Potential Cumulative Impacts on Environmental Factors**	**Cumulative Impact (if any)**
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no negative significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within transitional and coastal waters that are significantly downgradient to the proposed road development. The residual impacts on hydrogeology are imperceptible and there will be no negative significant cumulative impacts.	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no negative significant cumulative impacts on downstream estuarine and coastal waters.	
	Biodiversity: There will be no significant negative cumulative impacts as the proposed road development will not have any residual impacts on biodiversity along the coastline or in Galway Bay.	
Sáilín to Silverstrand Coastal Protection Scheme	This project only has the potential for a cumulative impact with Biodiversity. **Biodiversity:** There will be no significant negative cumulative impacts as the proposed road development will not have any residual impacts on biodiversity along the coastline or in Galway Bay.	
Salthill Coastal Protection Works (Blackrock to Galway Golf Club)	This project only has the potential for a cumulative impact with Biodiversity. **Biodiversity:** There will be no significant negative cumulative impacts as the proposed road development will not have any residual impacts on biodiversity along the coastline or in Galway Bay.	
Galway Transport Strategy (GTS),	**Socio Economic:** The proposed road development will facilitate the full implementation of the GTS and to provide for improved public transport and facilities for pedestrians and cyclists. Therefore, there will be an overall positive cumulative impact.	None
	Irish Language: The proposed road development will facilitate the full implementation of the GTS and improve connectivity for people in the Gaeltacht areas. Therefore, there will be an overall positive cumulative impact.	

<table>
<tr><th>Plan/Project</th><th>Potential Cumulative Impacts on Environmental Factors</th><th>Cumulative Impact (if any)</th></tr>
<tr><td rowspan="8">which includes the following:
Investigation of prospective sites to the east of the city for Park and Ride
Bearna Greenway
(part of the Galway to Spiddal Greenway)
Galway to Oughterard (part of the Galway to Clifden) Greenway
Galway City to Oranmore (part of the Galway to Dublin) Cycleway</td><td>Human Health: The proposed road development will facilitate the full implementation of the GTS and to provide for improved public transport and facilities for pedestrians and cyclists and the associated health benefits in terms of physical activity, improved accessibility and social inclusion. Therefore, there will be an overall positive cumulative impact.</td><td rowspan="8"></td></tr>
<tr><td>Material Assets Non-Agriculture: Whilst the GTS may result in significant impacts on material assets non agriculture, none of these material assets are also impacted by the proposed road development and therefore there will be no significant cumulative impacts</td></tr>
<tr><td>Material Assets Agriculture: Any potential impacts on agricultural lands as a result of the GTS will not be significant. Therefore, there will be no cumulative impacts.</td></tr>
<tr><td>Air Quality and Climate: The main objective of the GTS is to address the current and future transport requirements of Galway City and its environs. This includes the provision of new transport infrastructure. The proposed road development has been assessed with reference to the of the Galway Transport Strategy measures. There will be no significant cumulative impacts on air quality.</td></tr>
<tr><td>Noise and Vibration: The main objective of the GTS is to address the current and future transport requirements of Galway City and its environs. This includes the provision of new transport infrastructure which has not yet been fully developed. The proposed road development has been broadly assessed with reference to the Galway Transport Strategy and review of traffic re-distribution as a result of the proposed road development has been considered along existing roads. The GTS measures are unlikely to further adversely impact the noise and vibration impacts along the proposed road development.</td></tr>
<tr><td>Landscape and Visual: The GTS measures are unlikely to further adversely impact the landscape or visual setting along the proposed road development. There will be no significant negative cumulative impacts</td></tr>
<tr><td>Archaeology, Architectural and Cultural Heritage: The proposed Galway to Oughterard (part of the Galway to Clifden) Greenway will see the reopening of the railway line and potentially the repair of railway heritage features. The proposed road development will impact on a portion of the original railway line route where it passes through Dangan Lower. Sections of the railway line have been removed over the years due to differing activities, meaning that the proposed road development will result in a slight negative cumulative impact on the route of the original railway line. The proposed Galway to Oughterard Greenway scheme will have a positive impact on the cultural heritage of the area, which will help to offset the potential negative cumulative impact associated with the proposed road development. No negative residual impacts have been identified in association with the route of the former railway.</td></tr>
<tr><td>Soils and Geology: It is not envisaged that the GTS measures will have a significant impact on soils and geology. Therefore, there will be no negative significant cumulative impacts</td></tr>
</table>

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Hydrogeology: The GTS includes some realignment of local roads but these do not incorporate cuttings or structures that could impact on groundwater. Therefore, there will be no negative significant cumulative impacts	
	Hydrology: The GTS is at the plan stage so each individual measure will be subject to further detail design. The detailed design shall be in compliance with the surface water management and water quality objectives set out in the various development plans. Therefore, there will be no cumulative impacts associated with this development.	
	Biodiversity: Consideration of the GTS has also taken into account the full lengths of the greenways/cycleways of which only part are included within the GTS (e.g. Galway City to Oranmore Cycleway is part of the Galway to Dublin Cycleway). Considering the residual impacts associated with the proposed road development, the mitigation measures included within the GTS, and the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the *Galway City Council Development Plan 2017-2023*, no significant negative cumulative impacts are likely.	
Galway City Development Plan 2017–2023	**Socio Economic:** The proposed road development will help achieve objectives in the Galway City Development Plan and there will be a positive impact on quality of life for Galway City residents, accessibility for employment and amenity, economic development due to reduced congestion and improved connectivity, and residential and commercial development potential. There will be no significant negative cumulative impacts.	None
	Irish Language: The Galway City Development Plan includes objectives to promote the Irish Language. There will be no significant cumulative impacts with the proposed road development.	
	Human Health: The Galway City Development Plan includes objectives to improve physical activity, improved accessibility and social inclusion. There will be no significant cumulative impacts with the proposed road development.	
	Material Assets Non-Agriculture: Not applicable	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: Other than as considered in the landscape and visual assessment, it is not envisaged that any further significant cumulative impacts will arise from the proposed road development.	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Archaeology, Architectural and Cultural Heritage: There will be no cumulative impacts.	
	Soils and Geology: The Galway City Development Plan provides a series of objectives for waste management, and the sustainable management of construction and demolition (C&D) waste generated by development, while also outlining that development on contaminated lands include appropriate remediation measures. The Plan also sets out environmental protection policies. Therefore, there will be no significant cumulative impact.	
	Hydrogeology: Not applicable	
	Hydrology: The Galway City Development Plans set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no unacceptable hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and complying with the Flood Risk Management Planning Guidelines (2009). Therefore no significant cumulative impact with the proposed road development arises.	
	Biodiversity: The objectives within the City Council Development Plan, were assessed for potential cumulative impacts with the proposed road development. Considering the residual impacts associated with the proposed road development and the environmental protection policies included within the *Galway City Council Development Plan 2017-2023*, no significant negative cumulative impacts are likely.	
Galway County Development Plan 2015–2021	**Socio Economic:** The proposed road development will help achieve objectives in the Galway County Development Plan and there will be a positive impact on quality of life for Galway County residents, accessibility for employment and amenity, economic development due to reduced congestion and improved connectivity, and residential and commercial development potential. There will be no significant negative cumulative impacts.	None
	Irish Language: The Galway County Development Plan includes objectives to promote the Irish Language. There will be no significant cumulative impacts with the proposed road development.	
	Human Health: The proposed road development will help achieve objectives in the Galway County Development Plan and there will be a positive impact on quality of life for Galway County residents to improve physical activity, improved accessibility and social inclusion. There will be no significant cumulative impacts with the proposed road development.	
	Material Assets Non-Agriculture: Not applicable	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: Other than as considered in the landscape and visual assessment, it is not envisaged that any further significant cumulative impacts will arise from the proposed road development	
	Archaeology, Architectural and Cultural Heritage: There will be no cumulative impacts.	
	Soils and Geology: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within this Plan, no significant negative cumulative impacts are likely.	
	Hydrogeology: Not applicable	
	Hydrology: The Galway County Development Plan set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no unacceptable hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and complying with the Flood Risk Management Planning Guidelines (2009). Therefore no significant cumulative impact with the proposed road development will arise.	
	Biodiversity: The objectives within the County Council Development Plan, including proposals to upgrade/improve the R336 road between Bearna and Scríb and the N59 road between Clifden and Maam Cross were assessed under this plan for potential cumulative impacts. Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
Bearna Local Area Plan 2007–2017	**Socio Economic:** The proposed road development will reduce the volume of through traffic from Bearna Village and improve accessibility and connectivity for residents to employment and other destinations within Galway City and the rest of Ireland. This supports the objectives of the LAP by improving traffic flow and quality of life in Bearna. There will be no significant negative cumulative impacts.	None

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Irish Language: The Bearna Local Area Plan 2007-2017 (amended 2012) includes objectives to promote the Irish Language. There will be no significant cumulative impacts with the proposed road development.	
	Human Health: The proposed road development will reduce the volume of through traffic from Bearna Village and there will be opportunities to improve physical activity, improved accessibility and social inclusion. There will be no significant cumulative impacts with the proposed road development.	
	Material Assets Non-Agriculture: Not applicable	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: Other than as considered in the landscape and visual assessment, it is not envisaged that any further significant cumulative impacts will arise from the proposed road development	
	Archaeology, Architectural and Cultural Heritage: Not applicable	
	Soils and Geology: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within both the *Bearna Local Area Plan 2007–2017* and the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
	Hydrogeology: Not applicable	
	Hydrology: This set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no unacceptable hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and complying with the Flood Risk Management Planning Guidelines (2009). Therefore, no significant cumulative impact with the proposed road development will arise.	

Plan/Project	**Potential Cumulative Impacts on Environmental Factors**	**Cumulative Impact (if any)**
	Biodiversity: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within both the *Bearna Local Area Plan 2007–2017* and the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
Gaeltacht Local Area Plan 2008–2018	**Socio Economic:** The proposed road development will have a positive impact on residents living in the Gaeltacht arising from improved accessibility for employment and amenity and economic development. This supports the objectives of this Plan. There will be no significant negative cumulative impacts.	None
	Irish Language: The proposed road development will facilitate a strategic development principle of this LAP. Therefore, there will be an overall positive cumulative impact**.**	
	Human Health: The Galway County Development Plan includes objectives to improve physical activity, improved accessibility and social inclusion. There will be no significant cumulative impacts with the proposed road development.	
	Material Assets Non-Agriculture: Not applicable	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: Other than as considered in the landscape and visual assessment, it is not envisaged that any further significant cumulative impacts will arise from the proposed road development.	
	Archaeology, Architectural and Cultural Heritage: Not applicable	
	Soils and Geology: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within both the *Gaeltacht Local Area Plan 2008–2018* and the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
	Hydrogeology: Not applicable	
	Hydrology: This set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	unacceptable hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and complying with the Flood Risk Management Planning Guidelines (2009). Therefore, no significant cumulative impact with the proposed road development will arise.	
	Biodiversity: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within both the *Gaeltacht Local Area Plan 2008–2018* and the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
Údarás na Gaeltachta's Strategic Plan 2014–2017	**Socio Economic:** The proposed road development will have a positive impact on residents living in the Gaeltacht and West Galway County arising from improved accessibility for employment and amenity and economic development. This supports the objectives of this Plan. There will be no significant negative cumulative impacts.	None
	Irish Language: The proposed road development will facilitate a number of key objectives of this Strategic Plan. Therefore, there will be an overall positive cumulative impact.	
	Human Health: The proposed road development will have a positive impact on residents living in the Gaeltacht and West Galway County arising from improved accessibility and social inclusion. There will be no significant cumulative impacts with the proposed road development.	
	Material Assets Non-Agriculture: Not applicable	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: Not applicable	
	Archaeology, Architectural and Cultural Heritage: Not applicable	
	Soils and Geology: Not applicable	
	Hydrogeology: Not applicable	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Hydrology: Not applicable	
	Biodiversity: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the *Galway City Council Development Plan 2017-2023* no significant negative cumulative impacts are likely.	
Ardaun Local Area Plan 2018–2024	**Socio Economic:** The proposed road development will have a positive impact on residents living in Galway arising from improved accessibility for employment and amenity and economic development. This supports the objectives of this Plan. There will be no significant negative cumulative impacts.	None
	Irish Language: Not applicable.	
	Human Health: Not applicable.	
	Material Assets Non-Agriculture: Not applicable	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: While the Ardaun LAP envisages significant changes to the landscape and visual setting of the area, it is likely that the measures proposed will be delivered on a phased basis over a long period of time. Nevertheless, depending on timing of delivery, scope exists for some limited or insignificant cumulative landscape and visual impacts to arise.	
	Archaeology, Architectural and Cultural Heritage: Not applicable	
	Soils and Geology: The Ardaun Local Area Plan outlines that proposed developments will be guided in general by the objectives, development standards and guidelines of the City Development. Therefore, the residual impact associated with future proposed or planned developments in relation to soils and geology is imperceptible. Therefore, there will be no significant cumulative impact.	
	Hydrogeology: Not applicable	
	Hydrology: This set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	unacceptable hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and complying with the Flood Risk Management Planning Guidelines (2009). Therefore, no significant cumulative impact with the proposed road development will arise.	
	Biodiversity: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within both the *Ardaun Local Area Plan 2018–2024* and the *Galway City Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	

19.6 Transboundary Impacts

Transboundary impacts relate to potential impacts on other Member States, i.e. outside of the Republic of Ireland. Given the location of the proposed road development and extents of its zone of influence no transboundary impacts will arise.

19.7 References

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TII. (2017) *Road Safety Audit* GE-STY-01024.

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TII. (2017) *Road Safety Impact Assessment*. PE-PMG-02001.

European Commission. (2017), STREST: *Harmonized approach to stress tests for critical infrastructures against natural hazards*.

TII. (2017) *The Management of Waste from National Road Construction Projects* GE-ENV-01101.

20 Summary of Mitigation Measures and Residual Impacts

20.1 Introduction

An objective of the design of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, has been to reduce the adverse effects of the proposed road development on the environment to a practical minimum. Design measures and mitigation measures have been incorporated into the design of the proposed road development and will be applied during the construction and operation of the proposed road development.

Where unavoidable environmental effects have been identified during the environmental impact assessment process, measures have been proposed to mitigate these effects as much as reasonably possible. These mitigation measures are detailed in the respective chapters of the EIAR and are also presented in summary format in this chapter. These mitigation measures along with the design measures required for the proposed road development are presented in **Chapter 21, Schedule of Environmental Commitments** for ease of reference and inclusion in contract documents at a later stage.

Implementation of mitigation measures reduces the extent of effects occurring. However, there will be effects which are residual, after avoidance and mitigation have been considered i.e. residual impacts. All of the residual impacts are comprehensively detailed in the relevant chapters of the EIAR however, this chapter summarises the likely significant residual environmental impacts associated with the proposed road development. Throughout this document, where reference is made to 'residual impacts', it should also be understood to mean 'residual effects'.

20.2 Construction Phase

Table 20.1 below sets out the mitigation measures proposed in respect of each environmental factor along with a summary of the likely significant residual impacts predicted for the construction phase of the proposed road development.

Table 20.1: Assessment of Potential Impacts and Mitigation Measures – Construction Phase

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
Traffic		
Construction Traffic	The construction of the proposed road development will cause temporary short term traffic impacts on the local road network. The Construction Environmental Management Plan (CEMP), included in **Appendix A.7.5**, shall ensure that construction traffic impacts are minimised through the control of site access/egress routes and site access locations.	No likely significant residual impact.
General Construction Activity		
General Construction Activities	Mitigation measures for impacts to air quality (i.e. from dust), noise and vibration impacts, diversion of services and specific measures for soils and water are included in the respective sections of this table below. Every effort will be made to ensure that any negative environmental effects will be avoided, prevented or reduced during the construction phase. Any impacts to the existing environment such as deterioration of public roads used as haul routes will be repaired. Any structural damage caused to buildings/structures/wells as a result of the construction will undergo a full stabilisation and rehabilitation works. A Construction Environmental Management Plan (CEMP) has been prepared and is included in **Appendix A.7.5**. The CEMP will be updated and finalised by the Contractor prior to construction commencing and it will be updated with any additional measures which are required by the conditions attached to An Bord Pleanála's decision. All of the content provided in the CEMP will be implemented in full by the Contractor and its finalisation by the Contractor will not affect the robustness and adequacy of the information presented and relied upon in this EIAR. The plan has regard to the guidance contained in the handbook published by Construction Industry Research and Information Association (CIRIA) in the UK, *Environmental Good Practice on Site Guide, 4th Edition* (CIRIA 2015). The plan also has regard to the TII *Guidelines for the Creation, Implementation and Maintenance of an Environmental Operating Plan*. The CEMP summarises the overall environmental management strategy that will be adopted and implemented during the construction phase of the proposed road development. The purpose of the CEMP is to demonstrate how the proposed construction works can be delivered in a logical, sensible and safe sequence with the incorporation of specific environmental control measures relevant to construction works of this nature. The CEMP sets out the mechanism by which environmental protection is to be achieved during the construction phase of the proposed road development. Implementation of the CEMP will ensure disruption and nuisance are kept to a minimum. The CEMP has been prepared in conjunction with the Environmental Impact Assessment (EIA) Report and Natura Impact Statement (NIS), having regard to consultations with a range of specialists and environmental organisations, in particular, the National Parks and Wildlife Service (NPWS) and Inland Fisheries Ireland (IFI). The CEMP supports the information already provided in this EIAR and must be read in conjunction with the information already provided in this EIAR. In addition to the controls and mitigation presented below in **Table 20.1** and in the CEMP (**Appendix A.7.5**), please also refer to the following documents for additional details on construction methodologies for the significant structures: • River Corrib Bridge Constructability Examination **Appendix A.7.1** • Menlough Viaduct Constructability Examination **Appendix A.7.2** • Lackagh Tunnel Geotechnical and Hydrogeological Appraisal **Appendix A.7.3** • Galway Racecourse Tunnel Constructability Report **Appendix A.7.4** A construction management team shall be appointed for the duration of the construction phase. This team will supervise the construction of the proposed road development, including monitoring the performance of the Contractors to ensure that the proposed construction phase mitigation measures are implemented and that construction impacts and nuisance are minimised. The construction management team will liaise with neighbours and the general community during the construction phase to ensure that any disturbance is kept to a minimum. In order to help ensure the successful development, implementation and maintenance of the CEMP, the Contractor will be obliged to appoint a Site Environmental Manager (SEM). The SEM will possess sufficient training, experience and knowledge appropriate to the nature of the task to be undertaken. In particular, the SEM will require suitably qualified ecological experts to oversee ecologically sensitive elements of the construction works, ecological derogation licensing requirements and ecological monitoring. Further details on the roles and responsibilities of the SEM are provided throughout the CEMP document in **Appendix A.7.5**. The CEMP also outlines the communications strategy which will be adopted during the construction phase which ensures that awareness, education and information sharing procedures are adopted and implemented. Finally, the CEMP outlines the inspections, auditing and monitoring compliance strategy that will be adopted by the Contractor.	No likely significant residual impact.

Source / Scale of Effect	**Control and Mitigation**	**Significant Residual Impacts**
Debris	The following are the measures that will be taken to ensure that the construction site and surroundings are maintained to a high standard of cleanliness: • Daily inspections will be undertaken to monitor tidiness • A regular program of site tidying will be established to ensure a safe and orderly site • If necessary, scaffolding will have debris netting attached to prevent materials and equipment being scattered by the wind • Food waste will be strictly controlled on all parts of the site • Wheel wash facilities will be provided for vehicles exiting the construction site. Wheel wash run off will be stored in an onsite storage tank and will be disposed of by permitted waste haulage company at a permitted or licensed facility • In the unlikely event that mud is carried from the construction site to the public road, it will be cleaned as required and will not be allowed to accumulate • Loaded lorries and skips will be covered if required • Surrounding roads used by trucks for access to and egress from the site will be inspected regularly and cleaned, using an approved mechanical road sweeper, when required • In the event of any fugitive solid waste escaping the site, it will be collected immediately and removed to storage on site, and subsequently disposed of in the normal manner	No likely significant residual impact.
Waste Management	Waste generated during the construction phase will be carefully managed according to the accepted waste hierarchy which gives precedence to prevention, minimisation, reuse and recycling over disposal with energy recovery and finally disposal to landfill. This hierarchy will be implemented by identifying opportunities to firstly prevent waste from being produced, and secondly minimise the amount of waste produced. Where prevention and minimisation will not be feasible, ways to reuse or recycle waste will be sought, preferably on-site to avoid the impacts arising from transportation. If this is not feasible, opportunities to reuse or recycle the waste off-site will be investigated or waste will be sent to an energy recovery facility, and only where there is no alternative, will waste be disposed to landfill. All waste removed from the site will be collected only by Contractors with valid waste collection permits, under the Waste Management (Facility Permit and Registration) Regulations 2007 and (Amendment) Regulations 2008, 2014, 2015. All facilities to which waste will be taken will have appropriate waste licences or permits, under the Waste Management Act 1996, as amended, and the regulations thereunder, allowing them to accept the type of waste that is to be sent there. Hazardous waste generation will be minimised, and such waste will be recovered where feasible, and only disposed of if recovery is not feasible. Hazardous waste will be managed in accordance with the relevant legislation. All wastes from the construction of the proposed road development will be delivered to authorised waste facilities in accordance with the Waste Management Acts 1996-2016. By only using facilities with the appropriate waste permits/licence, Galway County Council will be satisfied that the Contractor will comply with the objectives of the Waste Management Act and that any environmental emissions (noise, dust, water) are managed at the destination site and therefore are legally the responsibility of the owner/operator of the destination site. In this manner Galway County Council can be satisfied that the off-site spoil management aspect of the development is legally compliant with environmental and waste management legislation. In general, construction waste materials may include general construction debris, scrap timber and steel, machinery oils and chemical cleaning solutions. The practice of excessive purchase of materials and equipment to allow for anticipated wastage will be avoided.	No likely significant residual impact.
Biodiversity		
General	All of the mitigation measures detailed below are included in the Schedule of Environmental Commitments (Refer to **Chapter 21, Schedule of Commitments**) which will be implemented by the Contractor under the supervision of the Project Ecologist (employed by the Employer) and/or the Ecological Clerk of Works (employed by the Contractor).	
Designated Areas for Nature Conservation	**European Sites** The mitigation measures that are specifically required to ensure that the proposed road development will not result in a likely significant effect (i.e. adversely affect the integrity of) on the European sites within its ZoI (Lough Corrib cSAC, Lough Corrib SPA, Galway Bay Complex cSAC and Inner Galway Bay SPA) are presented in Section 10 of the Natura Impact Statement (NIS). Following an assessment of the proposed road development on the identified relevant European sites, mitigation measures were developed to address the following potential impacts that were identified: • Habitat loss/fragmentation: mitigation measures to minimise habitat loss in Lough Corrib cSAC and to avoid loss of QI habitats within Lough Corrib cSAC during construction (Refer to section below on habitats and the CEMP **Appendix A.7.5**, River Corrib Bridge Constructability Examination **Appendix A.7.1**, Menlough Viaduct Constructability Examination **Appendix A.7.2**, Lackagh Tunnel Geotechnical and Hydrogeological Appraisal **Appendix A.7.3** • Habitat degradation – tunnelling/excavation: mitigation measures to maintain the structural integrity of the rock mass supporting QI habitats in Lough Corrib cSAC during the construction of the proposed Lackagh Tunnel (and its western approach) (Refer to Lackagh Tunnel Geotechnical and Hydrogeological Appraisal **Appendix A.7.3**) • Habitat degradation – hydrogeology: mitigation measures to avoid habitat degradation in Lough Corrib cSAC as a result of potential hydrogeological impacts during construction and operation (Refer to **Hydrogeology** section below and the CEMP **Appendix A.7.5**) • Habitat degradation – hydrology: mitigation measures to protect water quality in receiving watercourses during construction (Refer to **Hydrology** section below and the CEMP **Appendix A.7.5**)	No likely significant residual effect on any European sites.

Source / Scale of Effect	**Control and Mitigation**	**Significant Residual Impacts**
	• Habitat degradation – air quality: mitigation measures to control dust emissions during construction to prevent impacts on vegetation in Lough Corrib cSAC (Refer to **Hydrogeology** section below) • Habitat degradation – non-native invasive species: mitigation measures to avoid the introduction or spread of non-native invasive species to European sites during construction or operation (Refer to the Non-native Invasive Species Management Plan which forms part of the CEMP in **Appendix A.7.5**. • Disturbance/displacement: mitigation measures to avoid/reduce the disturbance/displacement effects of blasting on wintering birds using Ballindooley Lough (Refer to wintering birds section below) • Barrier effect: mitigation measures to avoid the proposed road development restricting Otter movement within the Bearna Stream catchment (Refer to Otter section below) • Mortality risk: mitigation measures to avoid mortality of the QI species of Lough Corrib cSAC. These include both measures to ensure that construction materials are not introduced into the River Corrib and to remove the risk of Otter being killed/injured due to collisions with road traffic (Refer to Otter section below). **Natural Heritage Areas and proposed Natural Heritage Areas** The potential for the proposed road development to significantly affect Lough Corrib pNHA or Galway Bay Complex pNHA is as per the corresponding European sites (Lough Corrib cSAC and Lough Corrib SPA in relation to Lough Corrib pNHA, and Galway Bay Complex cSAC and Inner Galway Bay SPA in relation to Galway Bay Complex pNHA). Therefore, the mitigation measures outlined above for European sites and as detailed in Section 10 of the NIS, will prevent the proposed road development resulting in a significant negative effect on Lough Corrib pNHA or Galway Bay Complex pNHA at the national geographic scale. The mitigation measures that are required to ensure that the proposed road development will not significantly affect Moycullen Bogs NHA are as follows: • Measures to control dust emissions during construction to prevent impacts to vegetation/habitats within Moycullen Bogs NHA at Tonabrocky – see Air Quality and Climate below. These include control measures such as spraying of exposed earthwork activities and site haul roads during dry weather, wheel washes, control of site vehicle speeds, road sweeping and dust screens. • Measures to avoid the introduction or spread of non-native invasive species to Moycullen Bogs NHA during construction or operation. These are detailed in the Non-native Invasive Species Management Plan which forms part of the CEMP in **Appendix A.7.5**. • Measures to control surface water runoff from the construction site to prevent an accidental pollution event affecting peatland habitats within Moycullen Bogs NHA at Tonabrocky – see Hydrology below	No likely significant residual effects on either Lough Corrib pNHA or Galway bay Complex pNHA or on any nationally designated areas for nature conservation.
Habitats	**Mitigation Measures to Minimise Habitat Loss** To minimise the loss of Annex I habitat, areas of these habitat types within the proposed development boundary but which are not required to construct the proposed road development will be retained and fenced off for the duration of construction. These are shown on **Figures 8.23.1** to **8.23.14**. To minimise the loss of habitat associated with the proposed road development, there are also areas within the proposed development boundary which are included for mitigation planting where general construction works will not be undertaken. These are shown on **Figures 8.23.1** to **8.23.14**. Where possible, woodland, scrub, treelines and hedgerows which lie within, or along the boundary of the proposed road development, that are not directly impacted by the proposed road alignment or drainage will be retained. These areas will be protected for the duration of construction works and fenced off at an appropriate distance. Vegetation to be retained is shown on **Figures 8.23.1** to **8.23.14** and on **Figures 12.2.01** to **12.2.14** (landscape design). Where possible, areas of river channel and bankside vegetation which lie within, or along the boundary of the proposed road development, that are not directly impacted by the proposed road alignment or drainage will be retained. These areas will be protected for the duration of construction works and fenced off at a distance of 5m from the stream/river bank. The Petrifying spring feature present in Lackagh Quarry, which lies c.25m to the north of the mainline of the proposed road development at Ch. 11+400, will be retained and shotcrete[1] will not be used as part of the quarry face stabilisation measures at the spring site. **Measures to Reduce the Potential for Impacts on Vegetation to be retained** Any vegetation (including trees, hedgerows or scrub adjacent to, or within, the proposed development boundary) which is to be retained shall be afforded adequate protection during the construction phase in accordance with the Guidelines for the Protection and Preservation of Trees, Hedgerows and Scrub Prior to, During and Post Construction of National Road Schemes (National Roads Authority, 2006b), as follows: • All trees along the proposed development boundary that are to be retained, both within and adjacent to the proposed development boundary (where the root protection area of the tree extends into the proposed development boundary), will be fenced off at the outset of works and for the duration of construction to avoid structural damage to the trunk, branches or root systems of	Despite these mitigation measures, the proposed road development will result in permanent area loss of the following Annex I habitat types, which are discussed further below: • Petrifying springs [*7220] • Residual alluvial forest [*91EO] • Limestone pavement [*8240] • Wet heath [4010] • Dry heath [4030] • Wet heath/Dry heath/*Molinia* mosaic [4010/4030/6410] • Calcareous grassland [6210] • *Molinia* meadow [6410] None of the areas of Annex I habitat that will be permanently lost are located within any European sites. In the case of the priority Annex I habitats lost outside European sites, this results in a likely significant residual effect at the international geographic scale. The exception is the loss of a Petrifying spring feature which results in a likely

[1] A concrete product which is sprayed at high velocity into a rock face as a structural/stabilising component.

<table>
<tr><th>Source / Scale of Effect</th><th>Control and Mitigation</th><th>Significant Residual Impacts</th></tr>
<tr><td></td><td>the trees. Temporary fencing will be erected at a sufficient distance from the tree so as to enclose the Root Protection Area (RPA) of the tree. The RPA will be defined based upon the recommendation of a qualified arborist.
• Where fencing is not feasible due to insufficient space, protection for the tree/hedgerow will be afforded by wrapping hessian sacking (or suitable equivalent) around the trunk of the tree and strapping stout buffer timbers around it.
• The area within the RPA will not be used for vehicle parking or the storage of materials (including soils, oils and chemicals). The storage of hazardous materials (e.g. hydrocarbons) or concrete washout areas will not be undertaken within 10m of any retained trees, hedgerows and treelines
○ A qualified arborist shall assess the condition of, and advise on any repair works necessary to, any trees which are to be retained or that lie outside of the proposed development boundary but whose RPA is impacted by the works. Any remedial works required will be carried out by a qualified arborist
○ A buffer zone of at least 5m will be maintained between construction works and retained hedgerows to ensure that the root protection areas are not damaged</td><td>significant negative residual effect at the county geographic scale.

For non-priority Annex I habitat types lost outside European sites, the habitat loss is considered to constitute a likely significant residual effect at the national geographic scale.

The habitat types, and areas lost, are summarised in Table 8.38 of Chapter 8, Biodiversity.
Similarly, despite the mitigation measures the proposed road development will result in likely significant residual effects, at the local geographic scale, on the following habitat of a local biodiversity value:
• Calcareous springs (FP1) - fifteen features
• Dry-humid acid grassland (GS3) - c.7.81ha
• Poor fen and flush (PF2) - c.0.13ha
• (Mixed) broadleaved woodland (WD1) - c.2.62ha
• Hedgerows (WL1) - c.7.8km
• Treelines (WL2) - c.4km</td></tr>
<tr><td>Measures to Reduce the Potential for Air Quality Impacts on biodiversity receptors during Construction</td><td>To control dust emissions during construction and protect many of the biodiversity receptors mitigation measures detailed below in the Air Quality and Climate section will be implemented.</td><td>No likely significant residual impact</td></tr>
<tr><td>Mitigation Measures to Reduce the Potential for Impacts to Water Quality in Receiving Watercourses</td><td>The mitigation measures to protect surface water during construction are detailed below in the Hydrology section and in the Construction Environmental Management Plan (CEMP) included in Appendix A.7.5 and in turn protect many of the biodiversity receptors.</td><td>No likely significant residual impact</td></tr>
<tr><td>Measures to Protect Groundwater Quantity and Groundwater Quality and potential impacts on biodiversity receptors</td><td>The mitigation measures to protect groundwater quantity and quality during construction are detailed in the Hydrogeology section below and in turn protect many of the biodiversity receptors.
Mitigation measures are also included below for Soils and Geology to restrict the use of fill material in areas where there is the potential for run off/infiltration to affect pH levels in adjoining peatland habitats within the operational hydrogeological Zone of Influence (ZoI) of the proposed road development.</td><td>No likely significant residual impact</td></tr>
<tr><td>Measures to Control and Prevent the Spread of Non-</td><td>The mitigation strategy in relation to non-native invasive plant species is outlined in the Non-native Invasive Species Management Plan included in the CEMP (see Appendix A.7.5) and will be implemented sufficiently far in advance of the proposed construction works commencing so as to allow time to adequately control all target non-native invasive species populations within the ZoI of the proposed road development, having regard to the specific timing/seasonal constraints that apply in relation to each individual species.</td><td>No likely significant residual impact.</td></tr>
</table>

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
native Invasive Species	The Non-Native Invasive Species Management Plan will direct the construction Contractor in implementing the specific mitigation measures required in relation to individual non-native invasive plant species and are required to protect many of the biodiversity receptors. As species may have spread, or their distribution may have changed, between the habitat surveys carried out for this EIAR and the commencement of construction works, the implementation of the Non-native Invasive Species Management Plan will include a pre-construction re-survey within the proposed development boundary. In accordance with the NRA guidance this survey will include accurate 1:5,000 scale mapping for the precise location of non-native invasive plant species. The pre-construction surveys will be undertaken by suitable experts with competence in identifying the species concerned. In accordance with the National Roads Authority, 2010a guidelines, where cut, pulled or mown noxious weed or non-native invasive plant species material arises, its disposal will not lead to a risk of further spread of the plants. Care will be taken near watercourses as water is a fast medium for the dispersal of plant fragments and seeds. Material that contains flower heads or seeds will be disposed of either by composting or burial at a depth of no less than 0.5m in the case of noxious weeds, or by incineration (at a licenced facility having regard to relevant legislation) or disposal to licensed landfill in the case of non-native invasive plant species. The taproots of docks and roots of creeping thistle are not suitable for composting or shallow burial, requiring disposal to landfill, incineration or burying at a depth of no less than 1.5m (practical only during the construction phase). Where burial is being used to dispose of Japanese knotweed, the material will be buried to a depth of 5m and overlain with a suitable geotextile membrane. All disposals will be carried out in accordance with the Waste Management Acts 1996-2011. In relation to aquatic non-native invasive plant species all construction works, and any aquatic survey work that may be carried out (e.g. electrofishing), will comply with best practice biosecurity protocols for aquatic work – for example IFI's Biosecurity Protocol for Field Survey Work (IFI, 2010).	
Rare and Protected Plants and Species	As there are no rare or legally protected plant species present within the ZoI of the proposed road development they will not be affected. Therefore, no mitigation measures are required.	No likely significant residual impact.
Otters	***Habitat degradation - water quality*** The mitigation measures relating to the protection of water quality in receiving watercourses during construction are outlined below for hydrology. ***Loss of breeding/resting sites*** As Otter could potentially establish new holt or couch sites within the ZoI of the proposed road development in the future, a pre-construction check of all suitable Otter habitat will be required within 12 months of any constructions works commencing.	No likely significant residual effect on Otter, at any geographic scale.
Bats	***Measures to Protect Bats during removal of Roosts*** It is an offence under Section 23 of the Wildlife Acts 1976-2017 and under Section 51 of the European Communities (Birds and Natural Habitats) Regulations, 2011 to kill a bat or to damage or destroy the breeding or resting place of any bat species. Under the European Communities (Birds and Natural Habitats) Regulations it is not necessary that the action should be deliberate for an offence to occur. This places an onus of due diligence on anyone proposing to carry out works that might result in such damage or destruction. Under Section 54 of S.I. 477 of 2011, a derogation may be granted by the Minister where there is no satisfactory alternative and the derogation is not detrimental to the maintenance of the populations of the species to which the Habitats Directive relates at a favourable conservation status in their natural range. Given the impacts on bats that are predicted for the proposed road development, a derogation licence under Section 54 of S.I. 477 of 2011 will be required. The Bat Derogation Licence application is included in **Appendix A.8.25**. The following mitigation measures are proposed in relation to structures either confirmed as supporting bat roosts or considered to have the potential to support roosting bats: • Prior to demolition of the 14 structures containing confirmed bat roosts, replacement artificial roosts will be in place to ensure that bats are able to access alternative resting places at the earliest opportunity. • Where possible, buildings with the confirmed bat roosts will not be demolished during the breeding period or hibernation period (April to mid-August and November-March) as the risk of accidental death or injury is higher at this time. Bats may use roosts in smaller numbers in winter but may nevertheless be present. Outside of these periods, the approach to demolition of bat roosts will determined on a case-by-case basis and subject to relevant licence conditions. • Buildings confirmed as bat roosts proposed for demolition will be marked on the ground with agreed paint marking to permit identification by Contractors. • Prior to demolitions, all structures that were confirmed as either having bats or having high potential for bats will be re-examined immediately prior to demolition to assess whether bats are present at the time of demolition. This will be an all-night examination to determine if bats enter the building during the night or early morning. This will provide adequate information to proceed with demolitions unless weather conditions were unsuitable for feeding bats. If bats are present, then they will require exclusion from the property over several nights or if possible physical removal by hand by a licenced bat specialist to be placed in a bat box or similar for release in the evening after capture. For structures which have not been confirmed as bat roosts but regarded to have high potential for bats, a bat detector assessment of the property to be demolished will be carried out, if demolitions are proposed during the period May – August (note this time period will not be permitted in the case of the confirmed bat roosts to be demolished). This will be an all-night examination to determine if bats enter the building during the night or early morning. This will provide adequate information to proceed with demolition unless weather conditions were unsuitable for feeding bats. If bats are present, then they will require exclusion from the property over several nights or if possible physical removal by hand by a licenced bat specialist to be placed in a bat box or similar for release in the evening after capture. • Once structures containing roosts are deemed to be clear of bats, the bat specialist will be on site to supervise the demolition procedure until the structure is no longer deemed able to support a bat roost. Bats may re-enter a partially demolished structure overnight so the bat specialist may be required to be present during demolition works until they are completed.	Significant residual impacts will still remain as some of the activities are unavoidable and can only be mitigated to a certain level of certainty: • Demolition of 14 buildings within the proposed development boundary which will affect local populations of Soprano pipistrelle bats, Common pipistrelle bats, Brown long-eared bats and Lesser horseshoe bats. • One maternity roost is being demolished, a Brown long-eared roost at Aughnacurra (PBR256) • One satellite roost for Lesser horseshoe bats will be demolished at Aughnacurra (PBR178) (believed to be a satellite roost for the Menlo Castle (PBR06) Lesser horseshoe maternity roost) • Loss of foraging habitat is regarded to be most significant in the Menlough area where woodland-pasture-hedgerow habitat is being lost and is within the CSZ for the nationally-important population of Lesser horseshoe bats. • Inevitable elevated mortality rates due to vehicle collisions. • Mortality and severance/barrier effects caused by the proposed road development on individual bats. Whilst best practice has been

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
	The following mitigation measures are proposed in relation to those trees identified as having high potential to support roosting bats. These include the two trees confirmed to have had bats present (PTR43, PTR48) or the 13 other trees to have high suitability, where either obvious potential roosting features are present, or where obscured by dense ivy cover, the tree is of an age and condition that there is a high chance that roosting features are present. **Figures 8.16.1** to **8.16.15** shows the locations of these trees but a more detailed drawing will be provided to the contractor prior to any felling works. Bats could occupy suitable roosting features at any time prior to the commencement of works. Therefore, there is an inherent risk that bats could be affected by the proposed felling works. The following mitigation procedures will be followed: • Felling of confirmed and potential tree roosts will be undertaken during the period September – October as during this period bats are capable of flight and may avoid the risks from tree felling if proper measures are undertaken, but also are neither breeding nor in hibernation • Use of detectors alone may not be sufficient to record bat emergence and re-entry in darkness. Therefore, prior to felling of confirmed and potential tree roosts, an emergence survey using infra-red illumination and video camera(s) and bat detectors will be carried out on the night immediately preceding the felling operation to determine if bats are present • Where it is safe and appropriate to do so for both bats and humans, such trees may be felled using heavy plant to push over the tree. In order to ensure the optimum warning for any roosting bats that may still be present, the tree will be pushed lightly two to three times, with a pause of approximately 30 seconds between each nudge to allow bats to become active. The tree should then be pushed to the ground slowly and should remain in place until it is inspected by a bat specialist • Trees should only be felled “in section” or “soft felled” where the sections can be rigged to avoid sudden movements or jarring of the sections • Where remedial works (e.g. pruning of limbs) is to be undertaken to trees deemed to be suitable for bats, the affected sections of the tree will be checked by a bat specialist (using endoscope under a separate derogation licence held by that individual) for potential roost features before removal. For limbs containing potential roost features high in the tree canopy, this will necessitate the rigging and lowering of the limb to the ground (with the potential roost feature intact) for inspection by the bat specialist before it is cut up or mulched. If bats are found to be present, they will be removed by a bat specialist licenced to handle bats and released in the area in the evening following capture Prior to felling the two confirmed tree roosts (PTR43 and PTR48) replacement bat boxes will be in place to ensure that bats are able to access alternative resting places at the earliest opportunity. The location of the bat boxes in these instances will be within the proposed development boundary but the precise height and location will be decided by the bat specialist. If any additional bat tree roosts are confirmed, and will be removed by the proposed felling works, then appropriate alternative roosting sites will be provided in the form of replacement bat boxes. ***Measures to preserve flight paths across Construction areas*** It has been identified that during the construction phase, the removal of woodland and hedgerows and other intervention in the landscapes used by bats can open up habitats to the extent that bats will not want to risk crossing the new open space to reach other roosts and foraging areas on the other side. This severance of flight paths will continue throughout the construction phase. The *Report WC1060 Development of a Cost-Effective Method for Monitoring the Effectiveness of Mitigation for Bats crossing linear infrastructure* includes best practice principles to address the general lack of evidence to show that many “conventional” mitigation measures work. These principles are reproduced below and have been adopted in the mitigation strategy for the proposed road development: • *“Mitigation should be integrated into the scheme from the earliest opportunity - mitigation should be considered during the planning and design stage of the infrastructure so that it can be incorporated effectively* • *Crossing structures should be placed on the exact location of existing bat commuting routes - attempts should not be made to divert bats from their existing commuting routes* • *Crossing structures should not require bats to alter flight height or direction: this will depend on the topography of the site: If the road is to be elevated above ground level an underpass may be used to preserve the commuting route below it, or if the road is in a cutting a green bridge may be used to carry the commuting route over the road* • *Crossing structures should maintain connectivity with existing bat commuting routes: connectivity must be maintained with undisturbed bat flight paths (e.g. treelines, hedgerows, woodland rides and streams), and bat habitat (e.g. woodland) within the surrounding landscape. Crossing structures should not be exposed or sited within open ground* • *Over-the-road structures such as green bridges should be planted with vegetation: vegetation should be continuous and connected (see above) and sufficiently mature before road construction (e.g. by planting either relatively mature trees or fast growing tree species in advance of construction commencing)* • *Underpasses should be of sufficient height: underpasses should be as spacious as possible with height being the critical factor. The minimum requirements for underpass height will be species-specific. Required heights will generally be lower for woodland-adapted species (~3 m) compared to generalist edge-adapted species (~6 m), but larger underpasses will accommodate more species* • *Green bridges should be of sufficient width: In addition to being vegetated, green bridges should be as wide as possible, to provide a large area for bats to commute across. Further research is needed to determine exact dimensions. We found a 30m wide green bridge to be effective in this study* • *Crossing structures should be unlit: The effects of light on bats are species-specific and lighting should be avoided* • *Access and connectivity must be maintained: It is important that access to crossing structures is maintained (e.g. grilles should not be installed on underpasses) and that connecting vegetation is retained indefinitely or for as long as the mitigation structure is required* • *Disturbance should be minimised during installation of mitigation structures: For example, by limiting noise and light pollution along the bat flight path, minimising vegetation clearance, installing suitable temporary crossing structures (which should also be subject to monitoring and evaluation), completing the installation as quickly as possible and ideally avoiding the summer months when bats are most active”* The installation of temporary fencing across sites to replace connecting features has been used and appears to have only been monitored as part of one project in Switzerland (Britschgi et al, 2004). In this study, a 1m wide x 1.5-2m high artificial hedgerow was recorded to be followed by a proportion of the bats in a roost. It is proposed to apply similar measures in key locations to ensure that there are linear features to connect habitats across the construction footprint.	followed in the design of the proposed road development and the inclusion of underpasses/culverts and a wildlife overpass, a small proportion of the local bat population will inevitably fly over the proposed road development and be vulnerable to vehicle collisions. A small proportion of the population will also be adversely affected by the barrier effect posed by the proposed road development across the landscape. The effect of this residual impact on Lesser horseshoe bats is predicted to be significant at a national geographic scale. The impact on other bat species is predicted to be significant at a local geographic scale. These residual impacts have been addressed further by the proposal for specific compensatory measures, which are further discussed in **Section 20.4.2** below.

<table>
<tr><th>Source / Scale of Effect</th><th>Control and Mitigation</th><th>Significant Residual Impacts</th></tr>
<tr><td></td><td>In order to inform siting of mitigation measures, including the temporary fencing described above during the construction phase, a series of infra-red/thermal camera surveys using a series of cameras and bat detectors along linear features in the following locations will be carried out in the optimum activity season. This will help to identify the preferred crossing points at the following sections:
Area 1: North of Bearna Woods
Area 2: Aughnacurra
Area 3: River Corrib to Coolough Road
Area 4: West of N84 Headford Road
Area 5: Ballindooley to Castlegar
Each area will be surveyed three times to record bats in flight in these locations with the precise vantage points for cameras to be determined during daytime surveys.
Any existing features that are identified as preferred crossing points and are scheduled for removal will be retained until the last moment and a portable artificial crossing structure put alongside it prior to its removal, so at no stage there is a gap across the construction site at night. The use of the temporary fence as an artificial crossing structure will be monitored three times over two weeks following installation. If the artificial crossing structure is not at the same location as a proposed permanent crossing point (e.g. the wildlife overpass at Castlegar) then it shall be moved gradually over several nights to realign it with the permanent crossing point.
The nature of the artificial crossing structure may comprise lengths of camouflage netting, recycled Christmas trees roped together, portable planters or artificial plants that can be easily moved at morning and evening to ensure that the crossing is in place each night.
Proposed monitoring programme
As the baseline level of bat activity and roost occupancy can change over time, pre-construction monitoring will be carried out in advance of construction works commencing to ensure that the data against which the post-construction monitoring will be compared to is as up-to-date as possible. Monitoring of the effectiveness of the bat mitigation and compensation measures will also be undertaken during and post-construction. Where the monitoring identifies issues with either the mitigation or compensation measures, these will be remediated to ensure that those measures will achieve their aims with respect to mitigating or compensating for impacts on the local bat populations.

Pre-construction monitoring
Pre-construction monitoring is required to provide data against which the post-construction monitoring can be compared. Parameters will include:
• Occupancy levels in roosts (Menlo Castle, proposed artificial roost buildings including retrofitted retained buildings, bat boxes)
• Bat passage structures (culverts, underpasses and the Castlegar Wildlife Overpass)
• Diversity of bat species and abundance of bat activity adjacent to the proposed road development
Occupancy levels in Menlo Castle will be measured by emergence surveys using infra-red video camera recording monthly from mid-April to September in the year of or immediately prior to construction commencing (whichever of the two is closer to the construction commencement).
Monitoring for bat usage of proposed bat passage structures will focus on recording bats using existing flight paths at proposed underpasses near Menlo Castle, the N59 Letteragh Junction and the proposed Castlegar Wildlife Overpass. Pre-construction baseline data is required on numbers of bats and flight height so that this can be compared to a post-construction scenario. Such data will be collected using focused infra-red camera and detector surveys carried out at least on three separate occasions at each location in the optimum survey period. In accordance with CEDR (2016) guidance it is proposed that this pre-construction monitoring involves a minimum of two separate surveys in the breeding season and two separate (in time) surveys in mid-August to late-September, to reflect periods of landscape-scale movements, and that these surveys take place for two bat activity seasons (May-August) following completion of the construction of the proposed road development.
The risk of adverse effects on bat diversity and abundance adjacent to the proposed road development can never be ruled out completely; but not all populations will be affected in the same location in the same way and therefore ongoing monitoring is regarded to be good practice to enhance our understanding of the effects of road developments and the effectiveness of mitigation measures. Diversity of bat species and abundance of bat activity adjacent to the proposed road development will be monitored using standardised survey transects from the edge of the proposed road development outwards as described by Berthinussen & Altringham (2015). These transects will be used to record bat activity across the lands flanking the corridor of the proposed road development. It is proposed that six transects are surveyed pre-construction in locations of high bat activity where underpasses or an overpass are proposed.
Refer to the Operational Biodiversity section below in relation to “During and Post Construction Monitoring”</td><td></td></tr>
<tr><td>Badger</td><td>Badger, and their breeding and resting places, are protected under the Wildlife Acts and it is an offence under that legislation to intentionally kill or injure a Badger or to wilfully interfere with or destroy their breeding or resting places (setts).
A comprehensive suite of mitigation measures has been incorporated into the proposed road development to ensure that Badgers are not intentionally killed or injured and that any impacts to their breeding or resting places will not affect their conservation status, at any geographic scale, and will not give rise to any likely significant effects on the species.
The mitigation measures described below follow the recommendations set out in the Guidelines for the Treatment of Badgers during the Construction of National Road Schemes (National Roads Authority, 2006). These guidelines set out the best practice approach in considering and mitigating impacts on Badgers during construction works.</td><td>No likely significant residual effect on Badger, at any geographic scale.</td></tr>
</table>

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
	A detailed summary of the mitigation measures as they relate to each of the Badger setts within the ZoI of the proposed road development is presented in **Appendix A.8.24**. The non-interference zones (30m, 50m and 150m), as they relate to each of the Bader setts within the ZoI of the proposed road development, are shown on **Figures 8.23.1** to **8.23.14**. As the usage of setts by Badgers can change over time, a pre-construction check of the activity status of all setts will be required within 12 months of any constructions works commencing within the ZoI of the setts discussed below. ***Disturbance/displacement*** In order to prevent any disturbance to Badger setts not directly affected by the proposed road development, no heavy machinery shall be used within 30m of Badger setts at any time. No works shall be under taken within 50m of active setts during the breeding season. Lighter machinery (generally wheeled vehicles) shall not be used within 20m of a sett entrance. Neither blasting nor pile driving shall be undertaken within 150m of active setts during the breeding season (December to June inclusive). Prior to works commencing, a non-interference zone of 30m will be established around each of the Badger setts within the ZoI of the proposed road development, as shown on **Figures 8.23.1** to **8.23.14**. If the sett is active, a non-interference zone will be extended to 50m during the breeding season (December to June inclusive). The fencing shall be as noted in **Chapter 7, Construction Activities** of a sufficient durability to maintain the exclusion zone throughout the construction period or, if required, until such time as the sett in question is excluded/removed. The mitigation measures, as they relate to each of the Badger setts within the ZoI of the proposed road development, are summarised in **Table 8.36** of **Chapter 8, Biodiversity** and illustrated on **Figures 8.23.1** to **8.23.14**. ***Loss of breeding/resting sites*** Where setts require exclusion and removal, or temporary exclusion for the duration of the construction period, this will be undertaken in accordance with the methodology detailed in the *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes* (National Roads Authority, 2006): • All Badger setts requiring exclusion and removal will require a monitoring period of at least five days to confirm activity status in advance of any construction works commencing • If the sett is active, then it shall not be removed within the Badger breeding season (December to June inclusive). To exclude or remove an active Badger sett outside of this period, inactive entrances shall be soft and hard-blocked with one-way gates installed on active entrances. One-way gates will be tied open for three days before being set to exclude, and then monitored for a period of at least 21 days before the sett is deemed inactive and destroyed. If at any time during the monitoring period the sett becomes active, the exclusion process/programme must commence again from day 1 of the 21-day monitoring period • For inactive setts, entrances will be soft-blocked (lightly blocked with vegetation and soil) and if all entrances remain undisturbed for a period of five days the sett should be destroyed immediately. This can be undertaken at any time of the year for inactive setts • An artificial sett is required to mitigate for the loss of the main sett (S9), in conjunction with a subsidiary sett (S11), of the Lackagh Badger group. The requirements relating to the provision and design of the artificial sett are set out in **Appendix A.8.24**. The location of the artificial sett is shown on **Figures 8.23.1** to **8.23.14**[2]. • Inaccessible areas (see **Figures 8.3.1** to **8.3.14**) will require a pre-works survey for badger setts in advance of site clearance. If a sett is uncovered, works must cease and a non-interference zone of 30m established; extended to 50m during the breeding season if set is active (December to June inclusive). Sett removal will follow the process outlined above	
Other Mammal Species	***Habitat degradation - water quality*** The mitigation measures relating to the protection of water quality in receiving watercourses during construction are outlined are outlined below for hydrology.	No likely significant residual impact on any other mammal species, at any geographic scale.
Invertebrates	**White-clawed crayfish & Freshwater pearl mussel** As there are no records of White-clawed crayfish or Freshwater pearl mussel from the area within the ZoI of the proposed road development they will not be affected. Therefore, no mitigation measures are required. **Marsh whorl snail** <u>Habitat Degradation – Surface Water Quality</u> The mitigation measures relating to the protection of water quality in receiving watercourses during construction are outlined below for hydrology. <u>Habitat Degradation – Groundwater.</u> The mitigation measures relating to the protection of the groundwater resource during construction are outlined below for hydrogeology. ***Marsh fritillary butterfly*** <u>Mortality Risk</u>	**White-clawed crayfish & Freshwater pearl mussel** No likely significant residual impacts are predicted. **Marsh whorl snail** No likely significant residual impact on the Marsh whorl snail, at any geographic scale. **Marsh fritillary**

[2] The closer an artificial sett is to the main sett being removed, the more likely it is to be used by the affected Badger group. Therefore, the artificial sett is proposed to be located approximately 60m to the north of S9. As the sett must be in place several months before works commence and the sett S9 is removed, the affected Badgers will have sufficient time to either adjust to the construction works in the vicinity of the artificial sett (which will involve blasting and rock breaking), relocate to another sett (e.g. S10), or construct a new sett elsewhere within their territory. Any disturbance from the construction works will be short-term and, even if the artificial sett is vacated during construction, its proximity to the operational road is not likely to deter badgers from occupying the sett at that time.

<table>
<tr><th>Source / Scale of Effect</th><th>Control and Mitigation</th><th>Significant Residual Impacts</th></tr>
<tr><td></td><td>To avoid the destruction of Marsh fritillary eggs or the mortality of Marsh fritillary caterpillars, the following mitigation strategy will be implemented in relation to the site clearance works:
• All areas within the proposed development boundary, which have been identified as suitable habitat to support the Marsh fritillary butterfly, will be subject to a pre-construction larval web survey. This will be undertaken during the mid-August to the end of September window immediately preceding site clearance works
• If larval webs are present, they will be translocated to another area of suitable habitat; either outside of the proposed development boundary or, if within, to an area of suitable habitat that will remain unaffected by construction works for the duration
• Once all larval webs have been removed from the affected areas, or if no larval webs were recorded, the vegetation will be immediately cleared or cut to ground level to render the area unsuitable for the species to recolonise. The vegetation shall be maintained in this state until such time as the topsoil is removed</td><td>No likely significant residual impact on the Marsh fritillary butterfly, at any geographic scale.</td></tr>
<tr><td>Birds</td><td>Breeding Birds
Habitat Loss, Disturbance and Destruction of Breeding Habitat
<u>General</u>
Where feasible, vegetation (e.g. hedgerows, trees, scrub and grassland) will not be removed, between the 1 March and the 31 August, to avoid direct impacts on nesting birds. Where the construction programme does not allow this seasonal restriction to be observed, then these areas will be inspected by a suitably qualified ecologist for the presence of breeding birds prior to clearance. Areas found not to contain nests will be cleared within 3 days of the nest survey, otherwise repeat surveys will be required.
Barn owl
To minimise the effects of current levels of disturbance to the Barn owl nest site at Menlo Castle, and thereby reduce any cumulative effect that construction activities nearby may have, alternative nesting sites will be provided in the vicinity. Three Barn owl nest boxes will be erected across the area shown on Figures 8.23.1 to 8.23.14 and will consist of either nest boxes erected on suitable trees or pole-mounted nest boxes. Preference will be given to erecting nest boxes on suitable trees, where possible.
Tree mounted boxes will be erected at least 3m above ground level on a mature tree with few or no low branches to obscure the nest box. The selected tree shall be either isolated in a hedgerow or situated on a woodland edge with the access hole facing open ground.
Pole-mounted nest boxes will be erected at a minimum height of 4.5m above ground.
The nest box design (e.g. entrance hole size, floor area and depth from the bottom of the entrance hole to the nest) shall be in accordance with the design requirements published by The Barn Owl Trust (<u>http://www.barnowltrust.org.uk/</u>). Nest boxes will be inspected annually for defects/damage and cleaned out/repaired as required to ensure waterproofness and the internal box depth.
Peregrine falcon
To minimise the potential for construction works near Lackagh Quarry to disturb the Peregrine falcon nest site, works from the Lackagh Tunnel to the N84 Headford Road Junction will commence prior to mid-February. This will ensure that any construction related disturbance, if its magnitude displaces Peregrine from the quarry for the duration of construction works, can influence the selection of the nest site and will not impact upon an incubating female on the nest. The installation of rock bolts on the cliff faces in the vicinity of the nest site will be undertaken in a sensitive manner (as advised by a suitably experienced ecologist) so as to minimise any potential disturbance to the nest site during the breeding season, particularly if the nest site is occupied.
Wintering Birds
Measures to Protect Wintering Birds during Construction
Construction noise will be kept to a minimum in accordance with BS 5228 (2009).
The contract documents will specify that the Contractor, undertaking the construction of the works, will be obliged to take specific noise abatement measures and will comply with the best practice outlined in British Standard BS 5228 – 1: 2009 +A1 2014: Code of practice for noise and vibration control on construction and open sites – Noise and the NRA (now TII) guidelines Good Practice Guideline for the Treatment of Noise during the planning of National Road Schemes (National Roads Authority, 2014).
Blasting associated with the eastern approach to Lackagh Quarry (Ch. 11+800 to Ch. 12+100) will be carried out between the months of April to September (inclusive) to minimise the exposure of wintering birds at Ballindooley Lough to blasting-related disturbance.
Blasting associated with the cutting at Castlegar (Ch. 12+550 to Ch. 13+650) will take approximately nine months to complete, with an estimated five blast events per week. To minimise the exposure of wintering birds at Ballindooley Lough to blasting-related disturbance, all of those nine months must be in the April to September period (inclusive) within consecutive years.</td><td>Breeding birds
No likely significant residual impact on breeding bird species, at any geographic scale, with the exception of the Peregrine falcon. Due to the likely permanent loss of Lackagh Quarry as a nesting site, the proposed road development is likely to result in a significant negative residual effect on Peregrine falcon, at the county geographic scale.

Wintering birds
No likely significant residual impact on wintering bird species, at any geographic scale.</td></tr>
<tr><td>Amphibians</td><td>Habitat Loss, Disturbance & Mortality Risk
If works to clear any of the habitat features suitable to support amphibian species are to begin during the season where frogspawn or tadpoles may be present (February – mid-summer), or where breeding adult newts, their eggs or larvae may be present (mid-March – September), a pre-construction survey will be undertaken to determine whether breeding amphibians are present.
In the case of Common frog, any frog spawn, tadpoles, juvenile or adult frogs present will be captured and removed from affected habitat by hand net and translocated to the nearest area of available suitable habitat, beyond the ZoI of the proposed road development.
In the case of Smooth newt, individuals will be captured and removed from affected habitat either by hand net or by trapping and translocated to the nearest area of available suitable habitat, beyond the ZoI of the proposed road development. If used, the type and design of traps shall be approved by the NPWS. This is a standard and proven method of catching and translocating Smooth newt.</td><td>No likely significant residual impact on the Common frog or the Smooth newt, at any geographic scale.</td></tr>
</table>

Source / Scale of Effect	**Control and Mitigation**	**Significant Residual Impacts**
	If the size or depth of the habitat feature is such that it cannot be determined whether all amphibians have been captured, it will be drained under the supervision of a suitably experienced ecologist to confirm that no amphibian species remain before it is destroyed or infilled. Any mechanical pumps used to drain the habitat feature will have a screen fitted, and be sited, such that no amphibian species can be sucked into the pump mechanism. Any capture and translocation works shall be undertaken immediately in advance of site clearance/construction works commencing. ***Habitat Degradation – Surface Water Quality*** The mitigation measures relating to the protection of water quality in receiving watercourses during construction are outlined below for Hydrology.	
Reptiles	**Measures to Protect Reptiles during Construction** ***Habitat Loss, Disturbance & Mortality Risk*** Given the broad range of habitat types favoured by the Common lizard, and that the majority of the proposed road development passes through mosaics of such habitats, site clearance works at any time of year in suitable habitat are highly likely to encounter the species, cause disturbance and have the potential to kill or injure individuals. In order to minimise the risk of site clearance and construction works disturbing, or causing the mortality of, Common lizard the following schedule of site clearance works will be followed in the areas highlighted on **Figures 8.10.1** to **8.10.8**, where the presence of Common lizard has been confirmed: • grass, scrub or heath vegetation will be removed during the winter period, where possible, avoiding potential Common lizard hibernacula sites (dry sites which provide frost-free conditions e.g. stone walls, underground small mammal burrows, piles of dead wood or rubble) • where this is not possible and clearance will be undertaken during the active season (March through to September, inclusive), vegetation will be cut first to approximately 15cm, and then to the ground, under supervision of an ecologist. This will allow the opportunity for lizards to be displaced by the disturbance and leave the affected area • stone walls (or other potential hibernacula sites) will be removed during the active season (March through to September, inclusive) under the supervision of an ecologist, when they are less likely to be in use by torpid lizards	No likely significant residual impact on the Common lizard, at any geographic scale.
Fish	**Measures to Protect Fish Species during Construction** ***Habitat Loss*** The structures have been designed in consultation with IFI and in accordance with the design criteria set out in *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes* (National Roads Authority**,** 2005) and the *Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters* (IFI, 2016). These measures, which include, in broad terms replicating the existing channel profile and substrate, will likely minimise the effects of habitat loss to a degree but it is acknowledged that this will be limited by the fact that they are artificial channels within a light limiting box structure. To minimise the effects of habitat loss on fish species, all sections of river/stream channel within the proposed development boundary, but not within the footprint of the proposed road development and associated infrastructure, will be protected from site clearance and construction works. Rivers/streams will be fenced off at a minimum distance of 5m from the river bank and within this zone the natural riparian vegetation will be retained. ***Habitat Degradation – Surface Water Quality*** The mitigation measures relating to the protection of water quality in receiving watercourses during construction are outlined below for hydrology ***Habitat Degradation – Groundwater*** The mitigation measures relating to the protection of the groundwater resource during construction are outlined below for Hydrogeology. ***Mortality Risk & Disturbance/Displacement*** To minimise the potential effects of construction works on fish species the following mitigation measures will be implemented: • No instream works will be carried out between the months of October and June (inclusive) to avoid the most sensitive time for fish species and fish species movements • Design of new sections of river channel shall be in accordance with the principles outlined in Channels & Challenges. Enhancing Salmonid Rivers. (O’Grady, 2006) • Immediately prior to rivers/streams being diverted into a newly constructed river channel or culvert, they will be electrofished (if required) to capture and transfer fish from the original channel to the new one. Once the watercourse has been diverted this will be followed by a manual search of the original watercourse to transfer any remaining fish to the new river/stream channel • Any water abstraction points required for dust suppression will be agreed with IFI and the suction head shall be screened to ensure that fish are not removed during the abstraction process ***Habitat Severance/Barrier Effect*** All temporary crossing structures used to cross watercourses during construction will be designed in accordance with the *Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters* (IFI, 2016) and *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes* (National Roads Authority, 2005) to maintain fish and macroinvertebrate passage, and to prevent sedimentation and erosion.	No likely significant negative residual impact on fish species, at any geographic scale.

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
Soils		
Earthworks construction	Construction techniques that comply with the requirements of statutory bodies in terms of noise, vibration, soil and groundwater contamination and disposal of contaminated material for both soil and rock cuttings will be adopted. **Loss of Agricultural Land and Solid Geology** All excavated material, excluding a small potential volume of hazardous material, will be re-used as construction fill and material deposition areas minimising the loss of the feature. The Contractor will ensure acceptability of the material for re-use within the proposed road development with appropriate handling, processing and segregation of the material. **Introduction of Material derived from a different Lithology** A construction earthworks programme will be implemented as part of the CEMP included in **Appendix A.7.5**, which is finalised by the Contractor, for the proposed road development which categorises the source of material for each fill section. During the finalisation of this programme, the fill limitations outlined below will be incorporated. To prevent impact to the local peatland habitats, the following fill limitations will be incorporated at the locations identified **Table 9.18** of **Chapter 9, Soils and Geology**. • Only pavement and capping layers protected from surface water runoff and groundwater movements are permitted to be derived from non-native material • All other acceptable fill material will be derived from native material or other pH compatible material **Flood Barrier** A drainage layer or starter layer, in accordance with the TII publication CC-SCD-00606, will be implemented for the construction of embankments in areas prone to flooding. The introduction of a drainage layer will ensure hydraulic conductivity exists across the flood plain and removes the risk of the embankment acting as a flood barrier. **Earthworks Haulage** Earthworks haulage will be along predetermined routes within and outside the proposed development boundary as shown on **Figures 7.101** to **7.123** of **Chapter 7, Construction Activities**. The identified haulage routes are along existing national, regional and local routes or within the proposed development boundary. Where compaction occurs due to truck movements and other construction activities on unfinished surfaces, remediation works will be undertaken to reinstate the ground to its original condition. Where practicable, compaction of any soil or subsoil which is to remain in-situ along the proposed road development will be avoided. **Washout of Fines/Sediment Runoff** The use of granular fill material in embankment construction will remove the likelihood of the washout of fines. However, in the event the embankment will be constructed of local material, the introduction of a drainage layer or starter layer (as discussed in Flood Barrier section above) will reduce the likelihood of run-off of fine material. Alternatively, the introduction of a geotextile separator will reduce the potential impact in areas. A composite system, combining a drainage layer and a geotextile separator will be implemented in embankments constructed with cohesive fill material. Sediment control methods are outlined in the CEMP in **Appendix A.7.5** and in the Hydrology and Hydrogeology sections below. **Effect on Surrounding Ground** Ground settlement, horizontal movement and vibration monitoring will be implemented during construction activities to ensure that the construction does not exceed the design limitations. In situations where the site specific blast design has determined that blasting is not feasible in a particular location due to excessive ground vibrations, alternative extraction methods such as hydraulic breaking, hydraulic splitting, chemical splitting and electrical disintegration may be implemented and monitored. Monitoring will be implemented during blasting, during excavation of cuts, for overburden slopes steeper than 1V:2H (V= vertical slope, H = horizontal slope) and rock slopes steeper than 1V:1.5H. A geotechnical expert will be appointed by the Contractor and will be present to monitor the surrounding ground vibrations near sensitive receptors during blasting works. In the unlikely event that the blast vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring. Allowable distances for the various construction methods are given in the section below on Noise and Vibration.	The small loss of the attribute (Limestone pavement (all outside European designated sites)) will result in a significant/moderate residual impact.
Reuse and processing of site material	A construction earthworks programme will be implemented for the proposed road development which categorises the source of material for each fill section. During the finalisation of this programme the fill limitations outlined above will be incorporated at the locations presented in **Table 9.18** of **Chapter 9, Soils and Geology**.	No likely significant residual impact.
Importation, exportation and disposal of materials	**Importation, exportation and disposal of materials** Importation of materials from outside the site will be minimised by ensuring that materials arising within the site area are used to the greatest extent possible. Any surplus material remaining which cannot be incorporated into the construction fill activities shall be placed in material deposition areas within the proposed road development. This will significantly reduce the deposition of material off-site. Hazardous material will be transported off site for disposal or recovery at appropriately licenced or permitted sites as outlined above in the section on Construction Activities and in the CEMP (**Appendix A.7.5**).	No likely significant residual impact.
Tunnelling	The adopted construction techniques will comply with the requirements of statutory bodies in terms of noise, vibration, soil and groundwater contamination and disposal of contaminated material.	

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
	During the construction of Lackagh Tunnel the supported rock face of Lackagh Quarry Face and retaining walls for the Western Approach will be monitored for movement. A geotechnical expert will be appointed by the Contractor and will be present to monitor the rock mass stability during their construction period. In the unlikely event that instability within the rock mass is observed, additional support measures will be installed to ensure that there is no impact to the surface above. The additional rock support measures comprise ground anchors, rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures, designed to the relevant design standards and best practice guidance documents. However, based on the conservative design approach it is considered that the risk of instability will be avoided and additional support measures will not be required. A geotechnical expert will be appointed by the Contractor and will be present to monitor the vibrations at the surface, including the areas of Limestone pavement, during blasting works for the construction of Lackagh Tunnel and the Western Approach. The blast target vibration limit is defined as 20% more conservative than the conservative design approach vibration limit of 25mm/sec at the ground surface which includes areas of Limestone pavement, which provides an added factor of safety to the construction works to ensure that blasting will not impact the structural integrity of the Limestone pavement. In the unlikely event that the blast target vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring. For further information on Lackagh Tunnel is presented in **Section 9.3.2.5** of **Chapter 9 Soils and Geology** and **Appendix A.7.3**.	No likely significant residual impact.
Construction of Structures	Construction of structures will be completed in accordance with the CEMP in **Appendix A.7.5**. The construction of the River Corrib Bridge will meet the requirements of the: River Corrib Bridge Constructability Examination **Appendix A.7.1**; the Menlough Viaduct will meet the requirements of the Menlough Viaduct Constructability Examination **Appendix A.7.2**, the Lackagh Tunnel will meet the requirements of the Lackagh Tunnel Geotechnical and Hydrogeological Appraisal **Appendix A.7.3** and the Galway Racecourse Tunnel will meet the requirements of the Galway Racecourse Tunnel Constructability Report **Appendix A.7.4**. Ground settlements will be controlled through selection of the foundation type and method of construction which are suitable for the particular ground conditions. To minimise soil movements due to pile operations in the vicinity of sensitive receptors, each pile shall be constructed sequentially in a direction away from the sensitive receptor. Previously installed piles act as a shield as soil movements are greater in a direction away from the stiffer zone i.e. away from the piles and sensitive receptors. During construction, the Limestone pavement at Menlough Viaduct will be protected and will not be impacted by implementing a protection system comprising of geogrid, protection geotextile and layers of material as shown on **Plate 9.2** in **Chapter 9, Soils and Geology**. This will be removed once construction is complete. Refer to Menlough Viaduct Constructability Report in **Appendix A.7.2** for further details.	No likely significant residual impact.
Contaminated ground	No known areas of contaminated ground were located within the study area. Samples of ground suspected of contamination will be tested for contamination during the detailed investigation and ground excavated from these areas will be disposed of to a suitably licence or permitted sites in accordance with the current Irish Waste Management legislation. Good housekeeping (daily site clean-ups, use of disposal bins, etc.) on the site, and the proper use, storage and disposal of these substances and their containers will prevent soil contamination. For all activities involving the use of potential pollutants or hazardous materials, material such as concrete, fuels, lubricants and hydraulic fluids will be carefully handled and stored to avoid spillages. Potential pollutants shall also be adequately secured against vandalism and will be provided with proper containment according to codes of practice. Any spillages will be immediately contained and contaminated soil removed from the site and disposed of to an appropriately permitted or licenced site according to the current Irish Waste Management Legislation by the Contractor. The Contractor is required to make provision for removal of any concrete wash water. Concrete trucks will be directed back to their batching plant for washout. The arrangement for concrete deliveries to the site will be discussed with suppliers before commencement of work, outlining the agreed assessed routes, prohibiting on site washout and discussing emergency procedures.	No likely significant residual impact.
Karst features	As a minimum, the carriageway drainage network will be sealed in areas where the proposed road development crosses rock particularly prone to karstification. Through the use of engineered solutions, including an impermeable barrier, cement slurry or grout, direct run-off from the paved surface of the proposed road development will be prevented from entering into the rock along the proposed alignment, as this could cause further deterioration and instability of the rock mass. Individual mitigation measures will be assessed on a case by case basis, determined by the extent of karst and make-up of the proposed road development as outlined in the karst protocol which is part of the CEMP in **Appendix A.7.5**. Inspections of karst features will be undertaken by a hydrogeologist and/or geotechnical expert in order to determine the appropriate remediation measure. These remedial measures include but are not limited to the removal of all loose, soft, weak or voided soil material, backfilling voids with an agreed combination of boulders cobbles/chunk rock/cement slurry and installation of a high strength geosynthetic to form a competent, safe foundation platform. Mitigation measures for the protection of karst features are further outlined in the section below on Hydrogeology and included in the CEMP in **Appendix A.7.5** as part of the karst protocol.	No likely significant residual impact.
Hydrogeology		
Groundwater Quantity and Quality	Through the evolution of the design of the proposed road development measures were included in the design to reduce or avoid specific impacts where possible. The following measures were incorporated into the design of the proposed road development: • No dewatering of the bedrock aquifer will occur during construction at Menlough Viaduct or Lackagh Tunnel (or its approaches). Furthermore, the construction sequence will take into account the seasonal groundwater fluctuation. During the winter groundwater high it may be necessary to limit the depth of works so that dewatering is not required. • Galway Granite Batholith EW01, 02 (three cuttings), 04, 07 and 09: Groundwater intercepted will be collected and piped to the surface water receptor it would naturally have drained to.	There are no residual hydrogeological impacts to European sites. Residual profound hydrogeological impacts remain for groundwater level drawdown impacts below the location of five Annex I habitats,

Source / Scale of Effect	**Control and Mitigation**	**Significant Residual Impacts**

	• Limestone: Construction dewatering of the bedrock aquifer may seasonally be required in EW27 during peak groundwater levels. Any dewatering will be discharged to the same GWB.
	• Construction of the Galway Racecourse Tunnel and its approaches will require dewatering of the bedrock aquifer. All groundwater intercepted will be managed and discharged within the same GWB.
	• EW27: Groundwater will be controlled within the excavation by collection in drains or sumps. If groundwater is intercepted, it will be piped and discharged at an infiltration basin within the same GWB. Intercepted groundwater is controlled and infiltrates back to the same groundwater body.
	• Where infiltration basins are used for discharge of site runoff during construction the runoff will be managed on site, collected and treated as per the Sediment Erosion and Pollution Control Plan (Refer to **Section 8** of the CEMP in **Appendix A.7.5**).
	
	The design of the proposed road development includes dewatering of the bedrock aquifer in cuttings in the Galway Granite Batholith and in cuttings in the Visean Undifferentiated Limestone with the exception of the construction of Menlough Viaduct or Lackagh Tunnel (or its approaches). The drawdown from these cuttings has been assessed. Drawdown impacts are limited in extent and do not impact on European sites or National Heritage Areas. No hydrogeological mitigation is proposed with regard to the design of construction dewatering.
	
	For the Visean Undifferentiated Limestone due to the risk of karst features being intercepted in excavations for earthworks (including viaducts, bridges and tunnels) and infiltration basins, mitigation measures have been developed to preserve the hydraulic connectivity of the feature and then seal it from the excavation. The Karst Protocol mitigation measure will ensure that there is no impact on groundwater flow paths to water dependant receptors. Karst mitigation plan is detailed in the CEMP in **Appendix A.7.5** and is summarised below in the section below on Aquifer Specific Mitigation Measures.
	
	Those infiltration basins in the Lough Corrib Fen 1 (Menlough) GWB (S19a and S19b) shall have additional measures incorporated into their construction to provide further protection to the groundwater body. Infiltration basin S19a and S19b include lining the sides of the excavation to ensure vertical groundwater infiltration so that all discharges drain through the placed subsoil for the full thickness of the unsaturated zone.
	
	Following the evaluation of potential impacts as a result of the design which includes the above measures, specific mitigation measures have been developed to avoid, prevent, reduce and, if possible, remedy any significant adverse impacts on hydrogeology as outlined below.
	Mitigation of potential construction impacts will be achieved through the stringent implementation of good construction practice procedures and environmental controls so as minimise the opportunity for contaminated releases of construction runoff as set out in the CEMP (**Appendix A.7.5**). Such practices will include adequate bunding for oil containers, wheel washers and dust suppression on site roads, and regular plant maintenance.
	The following measures included in the CEMP will be implemented to control the potential for pollution from accidental spillages on site:
	• Stockpiling of contaminated material is not permitted
	• Good housekeeping (daily site clean-ups, use of disposal bins, etc.) on the site during construction, and the proper use, storage and disposal of these substances and their containers will prevent groundwater contamination
	• For all activities involving the use of potential pollutants or hazardous materials, under the CEMP, the Contractor will be required to ensure that material such as concrete, fuels, lubricants and hydraulic fluids will be carefully handled and stored to avoid spillages. Potential pollutants shall also be adequately secured against vandalism and will be provided with proper containment according to codes of practice. Any spillages will be immediately contained and contaminated soil removed from the site and properly disposed of.
	• The Contractor will finalise the Incident Response Plan in the CEMP in **Appendix A.7.5** prior to work commencing and regularly update it for pollution emergencies which will be developed by the appointed Contractor. The plan will identify actions to be taken in the event of a pollution incident as per CIRIA guidance. As recommended in the CIRIA guidance, the contingency plan for pollution emergencies includes the following:
	  ○ Containment measures
	  ○ Emergency discharge routes
	  ○ List of appropriate equipment and clean-up materials
	  ○ Maintenance schedule for equipment
	  ○ Details of trained staff, location and provision for 24-hour cover
	  ○ Details of staff responsibilities
	  ○ Notification procedures to inform the Environmental Protection Agency (EPA) or environmental department of the Galway County Council
	  ○ Audit and review schedule
	  ○ Telephone numbers of statutory water consultees
	  ○ List of specialist pollution clean-up companies and their telephone numbers
	  ○ No direct untreated point discharge of construction runoff to groundwater will be permitted.
		outside of any European sites, on the Galway Granite Batholith at:
		• Na Foraí Maola Thiar Ch. 0+650 to Ch. 0:750
		• Na Foraí Maola Thoir Ch. 1+1250 to Ch. 1+500
		• Troscaigh Thiar (Ch. 1+850 to Ch. 2+400)
		• Aille (Ch. 3+300 to Ch. 3+900)
		• Ballyburke (Ch. 4+800 to Ch. 5+900)

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
Groundwater dependant receptors	○ Where a pollution incident is detected, construction works will be stopped until the source of the construction pollution has been identified and remedied. ○ Pollution control facilities and procedures set out in the Sediment, Erosion and Pollution Control Construction Management Plan included in the CEMP in **Appendix A.7.5** will be implemented if required. ○ The pollution control and treatment facilities will be installed and the monitoring network including instrumentation and procedures established prior to construction activities taking place on the ground in the vicinity of watercourses and sensitive surface and groundwater receptors. It is envisaged that the pollution control facilities will be monitored daily to ensure their continued function. A number of mitigation measures have also been developed specifically for groundwater dependent receptors. These are detailed below for aquifer, supply wells and habitats. **Aquifer** Aquifer specific mitigation measures are implemented where karst or high permeability zones are encountered during the construction programme. In the event of karst being encountered the Karst Protocol shall be implemented, which is documented in the CEMP (**Appendix A.7.5**). Application of the Karst Protocol are summarised below to detail where they will be implemented: • Where karst features are encountered during construction works these will be assessed by a hydrogeologist and an engineering geologist. These features will require their extent across the proposed road development to be delineated. In the case of excavations (road cuttings, tunnels, bridge pier excavations) then the karst feature shall be excavated and backfilled with course fill and sealed. This will prevent runoff draining into the feature and therefore protect against accidental spillage. On this basis, construction runoff will not discharge to a karst pathway and will receive natural attenuation and dilution in the aquifer • With regard to karst features being intercepted in excavations for earthworks (including viaducts, bridges and tunnels) and infiltration basins. The Karst Protocol preserves the hydraulic connectivity of the feature using granular material to fill but then seals the karst from the excavation using a liner (geotextile and or concrete depending on the site specifics) that will prevent linkage between excavation and the karst • Where dewatering of the bedrock aquifer is proposed, groundwater level monitoring will be installed before construction, during the construction phase and 12 months following construction to enable potential effects from dewatering to be identified. In the shallow cuts of the proposed road development there will be minimal dewatering of the bedrock aquifer required; nonetheless, a monitoring programme will be in place. If the monitoring indicates there is a measureable impact beyond that stated in this EIAR, then work with the potential to increase drawdown will be made safe and cease until the hydrogeological assessment is revised based on the site conditions and mitigation employed if appropriate • In order to reduce potential contamination impacts, stockpiling of contaminated material and leachate generation will be prohibited. In the situation that potential contaminated material is encountered it will be tested and disposed of in an appropriate manner and in line with current water management legislation. If it is not possible to immediately remove contaminated material, then it will be stored on, and covered by, polythene sheeting to prevent rain water infiltrating through the material. The time frame between excavation and removal will be kept to an absolute minimum **Supply Wells** The mitigation measures listed below will be adopted during the construction phase of the proposed road development: • Five wells (W50-10, W50-12, W50-13, W50-14 and W50-15) will be lost during the construction of the proposed road development. These will each be mitigated by providing a replacement well, connecting to mains supply where available or by financial compensation. Where wells have to be abandoned as part of the proposed road development they will be sealed and abandoned in general accordance with Well Drilling Guidelines produced by the Institute of Geologists of Ireland (IGI 2007) • Replacement wells, storage tank, associated pumping equipment and pipework for Wells W50-13 and W50-14 will be commissioned and tested to ensure adequate yield rates in advance of wells W50-13 and W50-14 being decommissioned • Wells outside of the proposed development boundary but within the drawdown zone of influence may be impacted by reduced groundwater levels during construction. All wells within 150m of the proposed development boundary (or 50m from the calculated drawdown ZoI if greater) will be monitored for water level on a monthly basis for 12 months before construction, during construction and for 12 months after construction. If the monitoring indicates that the proposed road development has impacted on a supply or geothermal well then mitigation will be applied • Standard mitigation measures and aquifer specific mitigation measures are employed for protection of groundwater. To ensure the protection of quality of groundwater potable supplies, all wells within 150m of the proposed development boundary will be monitored for water quality on a monthly basis. These wells will be monitored for standard drinking water quality parameters on a monthly basis for 12 months before construction, during construction and for 12 months after construction. If the monitoring indicates that the proposed road development has impacted on a supply, then mitigation will be applied **GWDTE** Those GWDTE that have been flagged as being at risk are all in areas where the groundwater pathways are karstic. In this regard the Karst Protocol (in the CEMP **Appendix A.7.5**), as detailed in the previous sections above, forms part of mitigation to prevent groundwater quality or quantity being impacted. Additional mitigation is also employed to ensure that European sites are not impacted.	

<table>
<tr><th>Source / Scale of Effect</th><th>Control and Mitigation</th><th>Significant Residual Impacts</th></tr>
<tr><td></td><td>Construction activities represent a potential source of impact on the water quality of the Coolagh Lakes, which form part of the Lough Corrib cSAC, from uncontrolled construction site runoff and potential contamination of the groundwater from construction spillages. There will be no surface water discharges to the Coolagh lakes and all runoff will be treated before being discharged to ground at infiltration basins. Infiltration basins are designed to include settlement to remove sediment and have an appropriate thickness of subsoil below invert level.

Pouring of the concrete in excavations (River Corrib Bridge, Menlough Viaduct and Lackagh Tunnel) will only be undertaken when the excavation has been inspected by a qualified hydrogeologist. Inspection of the full depth and extent of each excavation will be undertaken to identify if any significant flow paths, such as the karst enhancement of the bedrock permeability, are present. If no significant flow paths are present, then the hydrogeologist will document accordingly and confirm that there is no risk to groundwater from concrete leakage. If significant pathways are present then impacts which may arise from flow along these pathways shall be designed by the hydrogeologist based on the karst mitigation plan, these may comprise of installing a high permeability zone to replace the groundwater pathways which would be removed by the foundations and/or sealing the linkage from excavation to protect the karst. The design of the mitigation measures shall be approved by a qualified hydrogeologist to confirm that there will be no negative impacts to groundwater.
These above measures will ensure that the risk of pollution of groundwater bodies is controlled. These mitigation measures are employed during construction, the impacts on groundwater quality beneath the site will be of Negligible Magnitude and Imperceptible Significance.</td><td></td></tr>
<tr><td colspan="3">Hydrology</td></tr>
<tr><td>Drainage, general flood risk water quality, channel morphology and key ecological receptors</td><td>As is normal practice the CEMP included in Appendix A.7.5 will be finalised by the Contractor in advance of the commencement of construction and the following will be implemented as part this plan:
• An Incident Response Plan detailing the procedures to be undertaken in the event of spillage of chemical, fuel or other hazardous wastes, logging of non-compliance incidents and any such risks that could lead to a pollution incident, including flood risks (Refer to Section 10 of the CEMP in Appendix A.7.5)
• A Sediment Erosion and Pollution Control Plan (Refer to Section 8 of the CEMP in Appendix A.7.5). This shall include water quality monitoring and method statements to ensure compliance with environmental quality standards specified in the relevant legislation (i.e. surface water regulations and Salmonid Regulations 1988)
• All necessary permits and licenses for instream construction works associated with the provision of culverts, bridges and outfalls. OPW Section 50 consent has been received for all culverts and bridges proposed in the EIAR. Changes to these structures as part of the detailed design and construction stage will require new Section 50 consent to be obtained
• Inform and consult with OPW Western Arterial Drainage Section who have responsibility for the Corrib-Mask Arterial Drainage scheme and the ongoing control of river and lake levels at the Salmon Weir Barrage in Galway City
• Continue to inform and consult with Inland Fisheries Ireland (IFI)
• Continue to inform and consult with National Parks and Wildlife Service (NPWS)

Construction activities will be required to take cognisance of the following guidance documents for construction work on, over or near water:
• Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters (Inland Fisheries Ireland, 2016)
• Shannon Regional Fisheries Board – Protection and Conservation of Fisheries Habitat with particular reference to Road Construction
• Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites (Eastern Regional Fisheries Board)
• Central Fisheries Board Channels and Challenges – The Enhancement of Salmonid Rivers
• CIRIA C793 The SUDS Manual
• CIRIA C624 Development and Flood Risk – guidance for the construction industry
• CIRIA C532 Control of Water Pollution from Construction Sites Guidance for Consultants and Contractors
• CIRIA C648 Control of Water Pollution from Linear Construction Projects, technical guidance
• CIRIA C649 Control of Water Pollution from Linear Construction Projects, site guide
• Guidelines for the Crossing of Watercourses during the Construction of National Road schemes (NRA, 2006)
• Road Drainage and the Water Environment DN-DNG-03065 (TII, June 2015)
• Vegetated Drainage Systems for Road Runoff DN-DNG-03063 (TII, June 2015)

Based on the above guidance documents concerning control of construction impacts on the water environment, the following outlines the principal mitigation measures that will be prescribed for the construction phase in order to protect all catchment, watercourse and ecologically protected areas from direct and indirect impacts:
• All constructional compound areas will be required to be located on dry land and set back from river and stream channels and out of floodplain areas. Floodplain areas include the Flood Risk Zones A and B and therefore all construction compound areas need to be on lands above the 1000year return period flood level
• The storage of oils, fuel, chemicals, hydraulic fluids, etc. will not occur within 100m of the River Corrib or within the Floodplain Area as defined above</td><td>The will be no significant residual negative hydrological impacts on drainage and flood risk, water quality, channel morphology or key ecological receptors.</td></tr>
</table>

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
	• Surface water flowing onto the construction area will be minimised through the provision of temporary berms, diversion channels and cut-off ditches, where appropriate • Management of excess material stockpiles to prevent siltation of watercourse systems through runoff during rainstorms will be undertaken. This may involve allowing the establishment of vegetation on the exposed soil and the diversion of runoff water off these stockpiles to the construction settlement ponds and avoiding stockpiling of material in vicinity of sensitive watercourses • Where construction works are carried out adjacent to turloughs, fens, stream and river channels and lakes, protection of such waterbodies from silt load shall be carried out through use of reserved grassed buffer areas, timber fencing with silt fences or earthen berms. These measures will provide adequate treatment of constructional site runoff waters before reaching the watercourses • Use of settlement ponds, silt traps and bunds and minimising construction activities within watercourses. Where pumping of water is to be carried out, filters will be used at intake points and discharge will be through a sediment trap or sedi-mat • All watercourses that occur in areas of land that will be used for site compound/storage facilities will be fenced off at a minimum distance of 5m. In addition, measures will be implemented to ensure that silt laden or contaminated surface water runoff from the compound site does not discharge directly to the watercourse. Compounds shall not be constructed on lands designated as Flood Zone A or B in accordance with the OPW's The Planning System and Flood Risk Management Guidelines (November 2009). Site compounds will not be permitted in a European Sites (i.e. Lough Corrib cSAC) • Protection measures will be put in place to ensure that all hydrocarbons used during the construction phase are appropriately handled, stored and disposed of in accordance with the TII document "Guidelines for the crossing of watercourses during the construction of National Road Schemes". All chemical and fuel filling locations will be contained within bunded areas and set back a minimum of 10m from watercourses and floodplain areas • Foul drainage from all site offices and construction facilities will be contained and disposed of in an appropriate manner to prevent pollution • The construction discharge will be treated such that it will not reduce the environmental quality standard of the receiving watercourses • Riparian vegetation along the identified sensitive watercourses will be fenced off to provide a buffer zone of a minimum distance of 5m except for proposed crossing points for its protection • The use and management of concrete (which has a deleterious effect on water chemistry and aquatic habitats and species) in or close to watercourses will be carefully controlled to avoid spillage. Where on-site batching is proposed, this activity will be carried out well away from watercourses. Washout from such mixing plants will be carried out only in a designated contained impermeable area • All material deposition areas must be adequately bunded and compartmentalised such that the rainwater outflow from these facilities is adequately controlled and treated prior to reaching the receiving surface watercourses. The sediment control requirements are set out in the in the Sediment, Erosion and Pollution Control Construction Management Plan section of the CEMP (refer to **Appendix A.7.5**) To minimise the risk of contamination to the Galway Bay Complex cSAC a detailed Sediment, Erosion and Pollution Control Management Plan for the construction phase has been developed and included in the CEMP in **Appendix A.7.5**, which provides for avoidance, reduction, mitigation and monitoring. Construction hydrological and water quality impacts on the Galway Bay Complex cSAC and Inner Galway Bay SPA will be avoided.	

N83 Tuam Road Flood Risk	Provision of a storage area on the eastern side of the N83 Tuam Road to mitigate loss of flood storage from a pluvial flood risk area. The flood relief mitigation measures to eliminate this flood risk and reduce the existing flood risk in this area are as follows (refer also to **Figure 11.6** of **Chapter 11, Hydrology**):
	• Prevent the upgraded portion of the N83 Tuam Road from spilling laterally northwards into the driveways of existing flood risk houses by:
	  ○ Upgrade and provide effective road drainage network along the existing N83 Tuam Road. The proposed upgraded road drainage for the N83 portion extends for a length of 780m
	  ○ Provide interceptor drain to capture rapid hill slope runoff from the southeast reaching the N83 Tuam Road
	  ○ Provide for infiltration of this interceptor drain for the less severe rain storm events
	  ○ Connect this interceptor drain to the proposed flood compensation storage
	• Compensate flood storage lost by providing compensation storage of 8,030m^3 in the form of an excavated rectangular engineered storage pond with the base elevation of 16m OD and a top design water level elevation of 17.5m OD
	• Connect this compensation storage to the remaining low-lying natural flood storage area located to the northwest of the proposed road development so that both storage areas are hydraulically linked via culverts
	• Provide for a permanent pumping station and rising mains from the proposed compensation flood storage facility to discharge to the existing storm sewer with a pumping capacity of 250l/s
	
	Refer also to **Table 11.41** in **Chapter 11, Hydrology** which outlines the required storage volumes required for the catchment for a range of return periods and durations events.
	
	• The required flood storage, with an available pumping rate of 0.25cumec (i.e. 250l/s) from the engineered storage pond, is 20,700m^3 for the 100year event which is further increased to 24,800m^3 to include for 20% climate change
		There will be a moderate to significant positive residual impact on flooding and flood risk at N83 Tuam Road Twomileditch area, as the proposed mitigation measure will reduce the flood risk to the existing road and to the six remaining houses.
		
		However negative slight residual flood impacts associated with the N83 flood relief measures will remain:
		• Discharge of flood water into the Terryland Basin at 250 l/s resulting in slight increase in flood levels within the Terryland River channel. The impact of this discharge on flood levels in the Terryland Basin is minor representing a slight permanent residual impact on flood levels

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
	• The available storage provided in the engineered storage pond at a top water level of 17.5m OD is compensation storage of 8,030m^3 and the remaining (with proposed road development) natural storage provided of 18,470m^3 gives a total available flood storage of 26,500m^3, which is sufficient to achieve to meet and exceed the required storage.	• Reduction of available capacity within the existing storm sewer located to immediately south in the City North Business Park (the full bore capacity in the pipe is estimated to be 900l/s and therefore the proposed maximum discharge of 250l/s will reduce the available capacity by 27% This is considered a slight impact • Residual flood risk at the N83 Tuam Road associated with potential breakdown of the storm water pumping station, and blockage of storage area and associated drains and outfalls. This is considered slight in light of regular monthly inspections proposed
Landscape and Visual		
Site clearance and construction activities	Mitigation of landscape and visual impacts for the proposed road development shall have regard to the approach as set out in the following NRA/TII guidance documents: • Guidelines for the Creation and Maintenance of an Environmental Operating Plan (2007) • A Guide to Landscape Treatments for National Road Schemes in Ireland (2006) • Guidelines for the Protection and Preservation of Trees, Hedgerows and Scrub Prior to, During and Post Construction of National Road Schemes (2006) • Guidelines on the Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads (Revision 1, 2010) • Standard Construction Details (2000-2017) • Specification for Works (2000-2017) Landscape mitigation proposals shall take account of the approaches and principles as set out in A Guide to Landscape Treatments for National Road Schemes in Ireland, in particular to Chapter 4: Components of the Roadside Landscape; Chapter 5: Soil Geographic Factors; and Chapter 6: Landscape Treatments. Unless otherwise qualified in the following or in Chapter 8, Biodiversity, seeding and planting proposals, including species and planting type and species shall be in accordance with Chapter 6 of the Landscape Guidelines, adapted as required for local environmental and landscape conditions During the construction stage, the CEMP in **Appendix A.7.5** will be finalised and adopted by the Contractor'. Adherence to the CEMP will be a contract requirement and this will ensure good working practices are followed so as to minimise and manage any significant, negative environmental impacts arising from construction. As well as other items, the CEMP includes the mitigation set out within this chapter and incorporates these measures as part of their implementation. Mitigation will ensure that the works will have continuous monitoring under the CEMP so as to ensure adequate protection of areas outside of the construction works. Specific measures shall ensure that: • Site machinery shall operate within the proposed road development construction area • Storage areas shall be located so as to avoid impacting further on existing residential and other property, woodlands, trees, hedgerows, drainage patterns, etc. • Solid site hoarding of minimum 2.0m in height shall be provided alongside construction works adjoining residential property or recreational amenities • Solid hoarding or similar, of minimum 2.0m in height shall be provided along any side of a proposed construction compound, where they are located within 100m of residential properties • Construction compounds shall be fully-decommissioned and reinstated to their pre-construction condition at the end of the construction contract unless these areas have been identified as habitat compensation or material deposition areas • Side slopes and other landscape areas along the proposed road development shall be prepared for soiling, and either seeded and/or planted at the earliest possible opportunity. As such, some scope may exist for undertaking significant areas of seeding and planting prior to the end of the construction works. However, due to construction programming and seasonal restrictions, it is also likely that significant planting works will not be undertaken until the end of the major construction phase.	There will be significant residual impacts during construction until such time as the proposed landscape mitigation proposals establish and become increasingly effective.
Archaeology, Architectural and Cultural Heritage		
Construction activities including site clearance and demolition works	The proposed mitigation measures for the archaeological, architectural and cultural heritage are outlined below and detailed in **Appendix A.13.11**: A summary of all sites, structures, potential impacts and proposed mitigation is included in **Tables 13.21** to **13.26** in **Section 13.8** of **Chapter 13, Archaeological, Architectural and Cultural Heritage**. • A programme of archaeological test trenching will be carried out within the footprint of the proposed road development prior to construction going ahead. This will target the sites and areas of archaeological and cultural heritage potential as outlined in **Section 13.5.3** of **Chapter 13, Archaeological, Architectural and Cultural Heritage** as well as previously undisturbed areas within the proposed development boundary	No likely significant residual impact.

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
	• Test trenching will be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be identified, if that is deemed the most appropriate manner in which to proceed • Prior to demolition, the thatched cottage BH 12 will be subject to a full measured, written and photographic survey. This will be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist • The demesne landscape associated with Menlo Castle (DL 8), at Dangan Lower (DL7) and at Bushypark House (DL4) will be subject to a detailed photographic and written record prior to the construction of the proposed road development. This will be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist • All Cultural Heritage (CH) sites listed in **Table 13.17** of **Chapter 13, Archaeological, Architectural and Cultural Heritage** that include built heritage remains will be subject to a detailed written and photographic survey (to include test trenching where appropriate). This shall be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be identified, if that is deemed the most appropriate manner in which to proceed • Archaeological wade or underwater assessments will be carried out at any natural water courses (AAPs) to be impacted upon by the proposed road development by disturbance to their banks or beds. This shall be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be identified, if that is deemed the most appropriate manner in which to proceed • Any section of Townland Boundary to be impacted upon will be subject to a detailed written and photographic survey (to include test trenching where appropriate). This shall be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be identified, if that is deemed the most appropriate manner in which to proceed • Excavation of all previously recorded archaeological sites – where these fall, in whole or in part, within the footprint of the development – will be carried out under Ministerial Direction consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.	
Agriculture		
Construction activities	• The landowner will be provided with access to all separated land parcels during the construction of the proposed road development. Where temporary disruptions to this access occur landowners will be notified in advance • Where existing water and electricity supplies are disrupted during the construction phase an alternative water source or electricity supply will be made available e.g. water tanker or electric cable ducting. If access to surface drinking water sources are permanently restricted alternative groundwater supplies will be provided (or compensation to allow farmer drill his own well) • Suitable boundary fencing will be erected to delineate the line of the proposed development boundary and prevent disturbance to adjacent land • A key contact person will be appointed during the construction phase to facilitate communications between affected landowners and to facilitate the re-organisation of farm enterprises by farmers during critical times • Landowners with lands adjoining sites where either rock breaking, blasting or piling takes place will be notified in advance of these activities • The impacts on water quality will be minimised by way of a programme of mitigation measures for surface and ground water sources as described in the sections above on Hydrogeology and Hydrology • The spread of dust onto adjoining lands will be minimised by way of mitigation measures set out in the section below on Air Quality and Climate. Typically, the impact of dust on agricultural grazing livestock is not significant • Where drainage outfalls are temporarily altered or land drains blocked or damaged an adequate drainage outfall will be maintained and land drains will be repaired	The 48 Significant, 8 very significant and 12 profound construction impacts will remain and will be dealt with as part of the land acquisition process and will be agreed at a later date with a valuer. Compensation does not form part of the EIA process and is therefore not considered further.
Material Assets Non Agriculture		
Properties	• In the event of an approval of the Protected Road Scheme and Motorway Scheme and approval under Section 51 of the Roads Act 1993 (as amended), by An Bord Pleanála and subject to the availability of funding, Notice to Treat will be served firstly on owners, lessees and occupiers of the dwelling houses and commercial properties to be acquired, within six months of the scheme becoming operative, unless an application has been made for Judicial Review, in which case the Notice to Treat will be served in accordance with the provisions of Section 217 (6A) of the Planning and Development Act 2000 as inserted by the Compulsory Purchase Orders (Extension of Time Limits) Act 2010. Compensation will be agreed or determined by the property arbitrator as soon as possible after service of Notice to Treat. After compensation has been agreed or determined and satisfactory title has been produced, part payment can be made while the	The residual impacts from all of the very significant/significant impacts, 54 residential properties, eight commercial properties and one residential planning permission, which will be acquired and/or demolished to accommodate the proposed road development, remain as very

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<tr><th>Source / Scale of Effect</th><th>Control and Mitigation</th><th>Significant Residual Impacts</th></tr>
<tr><td></td><td>claimant remains for an agreed period in the property to be acquired. This will facilitate the claimant in removing uncertainty and will facilitate arrangements being made, as early as possible, to secure a replacement property.

Where existing access to property is affected, this will be reinstated or an alternative access provided.
Where part of a property or land surrounding a property is to be acquired, appropriate accesses have been designed and appropriate boundary treatment will be constructed.
The proposed road development severs the NUIG Sporting Campus facilities. During construction, restricted access across the construction area at the NUIG Sporting Campus facilities will be maintained.
Alternative pitch facilities will be provided to replace the existing pitches directly impacted by the proposed road development. The facilities include a floodlit 3G GAA pitch and a floodlit 3G training area and associated site infrastructure for the drainage of these pitches and furniture such as ball-stop netting. The proposed road development also intercepts the existing sports pavilion resulting in direct impacts to its western end and the building will be modified as follows:

the existing western plant room, 1 no. changing room, 1 no. storage area, 1 no. weights area and associated access hallways on both ground floor and upper levels will be demolished
the western plant room and its associated plant will be relocated
construction and reconfiguration of internal and external walls, roof, windows and door locations.

During the construction of the River Corrib Bridge, alternative access along the bank of the River Corrib will be provided
Temporary stables will be provided for Galway Racecourse during the construction of the proposed road development until such time as the Galway Racecourse Tunnel is complete and the permanent stables are constructed.
Mitigation measures as detailed in individual accommodation works agreements, such as boundary treatment, domestic entrances, property condition surveys (as outlined below for Noise and Vibration), provision of ducting to facilitate services, maintenance of access during construction amongst other items will remove impacts related to the properties with partial landtake. Compensatory measures for the loss of land, buildings and other injurious affection will form part of the land acquisition process and will be agreed at a later date with a valuer. Compensation does not form part of the EIA process and is therefore not considered further.
</td><td>significant/significant impacts as no mitigation is possible to reduce the impact. The residual impact post compensation cannot be assessed as the compensation to be agreed as part of the land acquisition is outside the scope of the EIA process.

Mitigation measures as detailed in individual accommodation works agreements will remove the residual impacts related to the properties with partial landtake.

There are no residual impacts on dwellings from which part of the road bed will be acquired or on services or services infrastructure.

The residual impacts on NUIG Sporting Campus remain as very significant in the absence of a new university sports masterplan. The proposed road development will effectively divide the sports campus into two, removing the two centrally located grass based sand carpet full sized GAA pitches. In tandem with this the existing context of the existing sporting changing facilities setting and curtilage will be altered completely. With an appropriate level of masterplanning and implementation of the following in such, a masterplan would reduce the residual impact to moderate:

The sporting campus at Dangan will require a new sporting campus plan and strategy to re-accommodate the removed pitches and ancillary sports pavilion. This must be in line with the university’s overall strategic sport’s vision
The removal of the existing sports fields will require replacement by similar or more likely improved facilities which allow for the more intensive use of the remaining reduced campus footprint
Utilities, roads and access and egress routes around the campus will require complete re-planning to re-integrate with the proposed road development
The remaining sports pitches will require remodelling to accommodate a more intensive use of the existing campus footprint
The landscape setting of the existing campus will need to be developed to screen the visual effects of the proposed River Corrib Bridge from the surrounding pitches.
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Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
		• Ancillary supporting facilities such as car parking and changing facilities will require remodelling The residual impact on NUIG Sporting Campus post compensation cannot be assessed as the compensation to be agreed as part of the land acquisition is outside the scope of the EIA process. There will be a positive residual impact on Galway Racecourse once the mitigation measures have been constructed with the provision of enhanced access to the premises and a new stable yard.
Services/Utilities	Each of the utility diversions associated with the proposed road development have been planned with ongoing and detailed engagement with relevant utility providers during the preparation of this EIAR. This engagement will continue prior to and during the construction phases. Each diversion has been assessed from both a construction point of view, but also from an operational point of view. Where the infrastructure for service providers is impacted, this will be diverted or reinstated in accordance with service providers' requirements prior to construction. Service users will be notified in advance of any temporary disruption or outages necessitated by the construction works. The disruption to services or outages will be carefully planned so the duration is minimised. Public water supply and foul water systems affected will be reconnected. All necessary diversions will be carried out in accordance with the local authority and Irish Water's requirements. Where private potable water supplies are impacted, a new well or alternative water supply or financial compensation for the loss of the well will be provided. Mitigation for interference with septic tanks will be agreed by the valuer at a later stage.	No likely significant residual impacts.
Air and Climate Change		
Air quality	Emissions to air during earthmoving and construction will occur, although the prevailing weather, the size of the site and its distance from sensitive receptors will assist in facilitating the management of any effects. The focus of the control procedures will therefore be to reduce the generation of airborne material. The assessment of potential construction impacts includes the implementation of 'standard mitigation', as stated in the TII Guidelines. This shall include the following measures: • Spraying of exposed earthwork activities and site haul roads during dry weather • Provision of wheel washes at exit points • Control of vehicle speeds and speed restrictions. It is proposed that site traffic is restricted to 20 km/hr. This will help to minimise the occurrence of dust re-suspension • Sweeping of hard surface roads In addition, the following measures will be implemented. These measures are based on best practice as outlined in the British Research Establishment (BRE) document 'Controlling particles, vapour and noise pollution from construction sites' and the Institute of Air Quality Management (IAQM) 'Guidance on the assessment of dust from demolition and construction', 2016. • A public communication strategy will be implemented by the Contractor which will outline procedures to inform members of the community on activities that may be disruptive, further details are contained in the CEMP in **Appendix A.7.5**. This appendix also includes details of a complaints register which will be implemented during the construction phase • Exhaust emissions from vehicles operating within the site, including trucks, excavators, diesel generators or other plant equipment, will be controlled by the Contractor through regular servicing of machinery • During dry periods when dust generation is likely or during windy periods, construction areas and vehicles delivering material with dust forming potential will also be sprayed with water, as appropriate • Areas where materials will be handled and stockpiled will be positioned away from main site access roads. These areas will also be designed to minimise their exposure to wind – all stockpiles shall be kept to the minimum practicable height with gentle slopes • There shall be no long-term stockpiling on site and storage time will be minimised • Material drop heights from plant to plant or from plant to stockpile will be minimised • Water suppression will be used during the demolition of buildings • Crushing and concrete batching plant will be located as far from sensitive receptors as is reasonably practicable. All storage bins and transfer points will be covered. Silos will be fitted with reverse jet air filters	No likely significant residual impact.

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
Climate	Dust screens will be implemented at locations where there is the potential for air quality impacts during the construction phase i.e. at locations where sensitive receptors are located within 100m of the works. In addition, a 2m dust screen will be provided at the locations in the areas of the overlap of the proposed road development and the Lough Corrib cSAC and where the proposed road development is adjacent to Moycullen Bogs NHA. Employee awareness is also a most important way that dust may be controlled on any site. Staff training and the vigilant management of operations ensure that all dust suppression methods are implemented and continuously inspected. Further details on employee training are provided in the CEMP in **Appendix A.7.5**. Dust deposition and PM_{10}/$PM_{2.5}$ monitoring shall be carried out to confirm the effectiveness of the mitigation measures. Dust deposition monitoring will also be conducted at a number of locations in the vicinity of the proposed road development. At a minimum, monitoring will be carried out at the two nearest sensitive receptors at locations where works of a 'major' scale is proposed while works are taking place in proximity. Monitoring will be carried out using the Bergerhoff method, i.e. analysis of dust collecting jars left on-site (German Standard VDI 2119, 1972). Results will be compared to the TA Luft guidelines. Should an exceedance of the TA Luft limit occur during the construction phase or a complaint be received in relation to dust levels, additional mitigation measures, for example more regular spraying of water, will be implemented. At least one month of dust deposition monitoring will be carried out in advance of the commencement of works to determine a baseline. In addition, it is proposed to carry out particulate monitoring (PM_{10} and $PM_{2.5}$) at the nearest sensitive receptors upwind and downwind of the construction works where sensitive receptors have been identified within 25m of the works. This monitoring programme will take place when works likely to generate dust are being carried out. The monitoring will allow direct comparison with the PM_{10} and $PM_{2.5}$ air quality standards on a daily basis. The particulate and dust deposition limits will be used to determine potential occurrences of dust nuisance associated with the proposed construction works. Should the limit values be approaching an exceedance during the construction works, the levels will be recorded by the Contractor. An investigation will subsequently be carried out to determine potential causes and the options available to reduce the level of dust. All potential causes for the high dust levels will be analysed. These will include the construction works taking place, potential off site sources and meteorological conditions. Should the construction works taking place be identified as the primary cause of the high level, the Contractor will ensure that the mitigation measures listed above are improved upon. Should high dust levels continue to occur following these improvements, the Contractor will provide alternative mitigation measures and/or will modify the construction works taking place. The following mitigation measures will be implemented during the construction phase of the development so as to minimise CO_2 emissions: • Materials required for the construction works will be sourced locally where possible. There are operational quarries located in proximity to the proposed road development. Rock crushing will be undertaken on site where possible, to reduce the requirement to import crushed stone to site • The Construction Traffic Management Plan outlined in the CEMP in **Appendix A.7.5** will be implemented in full. This will minimise congestion and encourage car sharing and the use of public transport • Materials will be handled efficiently on site to minimise the waiting time for loading and unloading, thereby reducing potential emissions. • Engines will be turned off when machinery is not in use • The regular maintenance of plant and equipment will be carried out • Materials with a reduced environmental impact will be used where available, such as: ○ Ground Granulated Blast Furnace Slag (GGBS) and Pulverished Fly Ash (PFA) will be used as replacements for Portland cements ○ Recycled steel The Contractor will be required to implement an Energy Management System for the duration of the works. This will include the following at a minimum: • Use of thermostatic controls on all heating systems in site buildings • The use of insulated temporary building structures • The use of low energy equipment and power saving functions on all computer systems • The use of low flow tap fittings and showers • The use of solar/thermal power to heat water for the on-site welfare facilities including sinks and showers.	No likely significant residual impact.
Noise and Vibration		
Noise	Mitigation measures for the construction phase are set out below in order to reduce potential impacts as far as practicable to within the adopted design goals for noise and vibration.	No likely significant residual impact.

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
	The contract documents will clearly specify the construction noise criteria included in **Chapter 17, Noise and Vibration** which the construction works must operate within. The Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Noise and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001. These measures will ensure that: • No plant used on site will be permitted to cause an ongoing public nuisance due to noise • The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations • All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract • Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers • Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use • Any plant, such as generators or pumps that is required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen • During the course of the construction programme, the Contractor will be required to manage the works to comply with the limits detailed in Table 17.1 of **Chapter 17, Noise and Vibration** using methods outlined in BS 5228-1:2009+A1 2011. Part 1 - Noise BS 5228 -1:2009+A1 2011includes guidance on several aspects of construction site practices, which include, but are not limited to: • Selection of quiet plant • Control of noise sources • Screening • Hours of work • Liaison with the public • Monitoring Further comment is offered on these items in the following paragraphs and in **Appendix A.17.2**, however specific control measures relating to construction activities undertaken by the Contractor will be set out within the construction noise and vibration management plan. Noise control measures that will be considered in the plan will include the selection of quiet plant, enclosures and screens around noise sources, limiting the hours of work and noise monitoring. Further information on these measures is provided below. The Contractor will be required to conduct construction noise predictions prior to works taking place and put in place the most appropriate noise control measures depending on the level of noise reduction required at any one location. **Selection of Quiet Plant** The potential for any item of plant to generate noise will be assessed prior to the item being brought onto the site. The least noisy item of plant will be selected wherever possible. Should a particular item of plant already on the site be found to generate high noise levels, the first action will be to identify whether or not said item can be replaced with a quieter alternative. For static plant such as compressors and generators used at work areas such as construction compounds etc., the units will be supplied with manufacturers' proprietary acoustic enclosures where possible. The Contractor will evaluate the choice of piling, excavation, breaking or other working method taking into account various ground conditions and site constraints. Where possible, where alternative lower noise generating equipment that would economically achieve, in the given ground conditions, equivalent structural/ excavation/ breaking results, these will be selected to minimise potential disturbance. The decision regarding the type of pile, excavation technique, rock breaking, crushing etc. to be used on a site will normally be governed by other engineering, environmental constraints. In these instances, it may not be possible for technical reasons to replace a noisy process by a quieter alternative (e.g. rotary bored piling over driven piles). Even if it is possible, the adoption of a quieter method may prolong the overall process (e.g. manual rock breaking versus blasting); the net result being that the overall disturbance to the community will not necessarily be reduced. **General Comments on Noise Control at Source** If replacing a noisy item of plant is not a viable or practical option, consideration will be given to noise control "at source". This refers to the modification of an item of plant, or the application of improved sound reduction methods in consultation with the supplier or the best practice use of equipment and materials handling to reduce noise. In practice, a balance may need to be struck between the use of all available techniques and the resulting costs of doing so. It is therefore proposed to adopt the concept of "*Best Available Techniques*" as defined in EC Directive 96/61. In this context "best" means "*the most effective in achieving a high general level of protection of the environment as a whole*". The expression "*available techniques*" means "*those techniques developed on a scale which allows implementation…., under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced within the State, as long as they are reasonably accessible to the operator carrying on the activity*". The term "*techniques*" includes "*both the technology used and the way in which the installation is designed, built, managed, maintained, operated and decommissioned*".	

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
	Thus, the concept of Best Available Techniques requires a degree of balance between the attainment of environmental benefits and the likely cost implications. In the identification of Best Available Techniques, regard will be had to a wide range of factors, however, emphasis will be given to "*practical suitability*" and the need "*to reduce an emission and its impact on the environment as a whole*". Proposed techniques will also be evaluated in light of their potential effect on occupational health and safety. The following outline guidance relates to practical noise control at source techniques which relate to specific site considerations: • For mobile plant items such as cranes, dump trucks, excavators and loaders, the installation of an acoustic exhaust and/or maintaining enclosure panels closed during operation can reduce noise levels by up to 10dB. Mobile plant will be switched off when not in use and not left idling • For piling plant, noise reduction can be achieved by enclosing the driving system in an acoustic shroud. For steady continuous noise, such as that generated by diesel engines, it is possible to reduce the noise emitted by fitting a more effective exhaust silencer system or utilising an acoustic canopy to replace the normal engine cover • For percussive tools such as pneumatic concrete breakers, rock drills and tools a number of noise control measures include fitting muffler or sound reducing equipment to the breaker 'tool' and ensuring any leaks in the air lines are sealed. Erection of localised screens around breaker or drill bit when in operation in close proximity to noise sensitive boundaries are other suitable forms of noise reduction • For concrete mixers, control measures will be employed during cleaning to ensure no impulsive hammering is undertaken at the mixer drum • For all materials handling, the Contractor will ensure that best practice site noise control measures are implemented including ensuring that materials are not dropped from excessive heights and drop chutes/dump trucks are lined with resilient materials. This is an important consideration for site compounds where materials are loaded and unloaded. Site compounds in close proximity to noise sensitive areas (refer to **Table 17.10** of **Chapter 17, Noise and Vibration**) will incorporate a strict noise control policy relating to materials handling • Where compressors, generators and pumps are located in areas in close proximity to noise sensitive properties/ areas and have potential to exceed noise criterion, these will be surrounded by acoustic lagging or enclosed within acoustic enclosures providing air ventilation • Resonance effects in panel work or cover plates can be reduced through stiffening or application of damping compounds; rattling and grinding noises can be controlled by fixing resilient materials in between the surfaces in contact • Demountable enclosures can also be used to screen operatives using hand tools and may be moved around site as necessary • All items of plant will be subject to regular maintenance. Such maintenance can prevent unnecessary increases in plant noise and can serve to prolong the effectiveness of noise control measures **Screening** Typically screening is an effective method of reducing the noise level at a receiver location and can be used successfully as an additional measure to other forms of noise control. The effectiveness of a noise screen will depend on the height and length of the screen, its mass, and its position relative to both the source and receiver. The length of the screen should in practice be at least five times the height, however, if shorter sections are necessary then the ends of the screen will be wrapped around the source. *BS 5228 -1:2009+A1 2011*states that on level sites the screen should be placed as close as possible to either the source or the receiver. The construction of the barrier will be such that there are no gaps or openings at joints in the screen material. In most practical situations the effectiveness of the screen is limited by the sound transmission over the top of the barrier rather than the transmission through the barrier itself. In practice screens constructed of materials with a mass per unit of surface area greater than 10 kg/m^2 will give adequate sound insulation performance. As an example, the use of a standard 2.4m high construction site hoarding will provide a sufficient level of noise screening once it is installed at a suitable position between the source and receiver. Annex B of *BS 5228-1:2009+A1:2014* (Figures B1, B2 and B3) provide typical details for temporary and mobile acoustic screens, sheds and enclosures that can be constructed on site from standard materials. In addition, careful planning of the site layout will also be considered. Within site compounds, the placement of site buildings such as offices and stores between the site and sensitive locations can provide a good level of noise screening. Similarly, in some instances materials such as topsoil or aggregate along the route of the proposed road development can provide a degree of noise screening if placed between the source and the receiver. **Hours of Work** Construction activity will mostly take place during daytime hours Monday to Friday and Saturdays (ref **Section 17.2.2.1** of **Chapter 17, Noise and Vibration**). Depending on the noise emission levels experienced and associated noise impact, the Contractor will be flexible and able to conduct certain works at hours which reflect periods when the neighbouring properties have lower sensitivities to noise. It will be necessary to work overtime (including weekends) and night shifts at certain critical stages during the project. Over the expected 36-month construction phase there will be up to 10 weeks of night time working along different sections of the proposed road development primarily to facilitate bridge works over existing roads. Consideration will be given to the scheduling of activities in a manner that reflects the location of the site and the nature of neighbouring properties. Each potentially noisy event/activity will be considered on its individual merits and scheduled according to its noise level, proximity to sensitive locations and possible options for noise control. In situations where a particularly noisy activity is scheduled e.g. activities identified in **Table 17.9, Chapter 17, Noise and Vibration** (rock breaking/crushing/impact piling etc.) or other activities of similar noise level, the use of other on-site activities will be scheduled to control cumulative noise levels. **Liaison with the Public**	

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
	On typical road construction sites, the major sources of noise are essentially mobile and the noise received at any control points will therefore vary from day to day as work proceeds. The duration of piling, excavation, breaking and other high noise or vibration activities works is usually short in relation to the length of construction work as a whole, and the amount of time spent working near to sensitive areas can represent only a part of the overall period. It is important, therefore, that clear forms of communication are established between the Contractor and noise sensitive areas in proximity so that residents or building occupants are aware of the likely duration of activities likely to generate higher noise or vibration. A designated noise liaison officer will be appointed to site during construction works. All noise complaints will be logged and followed up in a prompt fashion by the liaison officer. **Monitoring** During the construction phase noise monitoring will be undertaken at the nearest sensitive locations to ensure construction noise limits outlined in **Table 17.1** of **Chapter 17, Noise and Vibration** are not exceeded. Noise monitoring will be conducted in accordance with the International Standard ISO 1996: *Acoustics – Description, measurement and assessment of environmental noise* Part 1 (2016) and Part 2 (2017). The selection of monitoring locations will be based on the nearest sensitive buildings to the working area which will progress along the length of the road construction. It is recommended that noise control audits are conducted at regular intervals throughout the construction programme in conjunction with noise monitoring. The purpose of the audits will be to ensure that all appropriate steps are being taken to control construction noise emissions and to identify opportunities for improvement, where required.	
Blasting and Air Overpressure	Air overpressure from a blast is difficult to control because of its variability, however, much can be done to reduce the effect and the control of the blast design at source. In terms of blast design control, specific guidance will be obtained from the recommendations contained within BS 5228-2:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Vibration in relation to blasting operations in addition to experienced blast control techniques used by the Contractor. These will include some or all of the following: • All blasting will be undertaken by professionally trained blast Contractors • Restriction of hours within which blasting can be conducted (09:00 –18:00hrs) • Trial blasts will be tested in less sensitive areas to assist in blast designs and identify potential zones of influence • Explosive charges will be properly confined by a sufficient amount of stemming • Blasting Contractors will ensure that the minimum amount of primer cord is used, and that no primer cord is located above ground • Profiling will be carried out after each blast in order to ensure the geometry of the rock face can be established, enabling the optimum burden and spacing to be applied for subsequent blasts; • The design, execution and completion of any blasting within 150 metres of any existing structure shall require special considerations. This will include the use of pre and post condition structural surveys by a competent structural engineer • Ground vibration and air over pressure (AOP) will be recorded simultaneously for each blast at the most sensitive locations, depending on the works area being blasted • When blasting moves into a new area, an initial low level blast will be carried out (i.e. a low Maximum Instantaneous Charge (MIC)) and monitoring will be carried out simultaneously at a number of sensitive properties in different directions in order to generate specific scaled distance graphs • The scaled distance graphs will be used to determine the optimum MIC for subsequent blasts area in order control vibration and AOP limits below the relevant limit values (as set out in **Section 17.2.1** of **Chapter 17, Noise and Vibration**) at the nearest sensitive buildings	No likely significant residual impact.
Vibration	In line with best practice mitigation measures from vibration sources, good communication and public relations are a key factor in reducing any startle effects to residents. In this instance, a Public Communications Strategy will be implemented by the Contractor prior to the commencement of any blast works. In such cases, the following recommended mitigation measures are proposed: • Relevant nearby residents will be notified before any work and blasting starts (e.g. a minimum of 24-hour written notification) • The firing of blasts will be undertaken, where possible, at similar times to reduce the 'startle' effect • Ongoing circulars will be issued informing people of the progress of the blasting works • The implementation of an onsite documented complaints procedure will be maintained by the Contractor • The use of independent monitoring will be undertaken by external bodies for verification of results The TII Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities should be limited to the values set out in **Table 17.3, Chapter 17, Noise and Vibration**. On review of the likely vibration levels associated with construction activities, it may be concluded that the construction of the proposed road development is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or cosmetic damage to buildings. In the case of vibration levels giving rise to human discomfort, in order to minimise such impacts, the following measures shall be implemented during the construction period:	No likely significant residual impact.

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
	• A clear communication programme will be established to inform adjacent building occupants in advance of any potential intrusive works which may give rise to vibration levels likely to exceed perceptible levels. The nature and duration of the works will be clearly set out in all communication circulars • Alternative less intensive working methods and/or plant items shall be employed, where feasible • Appropriate vibration isolation shall be applied to plant, where feasible • Cut off trenches to isolate the vibration transmission path shall be installed where required • In the case of impact piling or demolition works for instance, a reduction in the input energy per blow shall be considered where required • Monitoring will be undertaken at identified sensitive buildings, where proposed works have the potential to be at or exceed the vibration limit values **Property Condition Surveys** Property condition surveys will be offered for all buildings within 50m of the proposed development boundary and those within 150m of proposed blasting works along the proposed road development. Property condition surveys will also be carried out at buildings and structures considered appropriate relative to their proximity to the works. Such property condition surveys shall be carried out by a Chartered Surveyor or Chartered Structural Engineer. Such property condition surveys, subject to the written agreement of relevant property owners, shall be carried out in two stages as the follows: • the first stage shall consist of pre-construction condition surveys including photographic records which shall be carried out prior to the commencement of construction • the second stage shall consist of post-construction condition surveys which shall include photographic records **Disturbance of Particularly Vibration-Sensitive Equipment and Processes** The location of potentially vibration sensitive activities have been identified for manufacturing facilities within the Parkmore and Racecourse Business Parks. This location is in proximity to an area where blasting will take place as part of the proposed tunnel at Ballybrit. The most effective form of mitigation for this type of sensitive process is through on-going consultation with the property owners as the design and construction of the proposed road development progresses. This will involve baseline vibration monitoring and the use of trial blasts using an initial low level charge with simultaneously vibration measurements undertaken at the building. This information will be used to determine acceptable vibration levels for the facility relating to the sensitivity of the operating equipment. The results of this trial assessment will then set appropriate agreed limits values at the facility in question which will be monitored during subsequent blasts or other excavation methodologies. Where no safe limit is determined, the timing and scheduling of blasts will be undertaken in consultation with the facility when no sensitive operations are taking place. Given the short time period over which an individual blast takes place (i.e. a number of seconds), this approach is deemed to be feasible.	
Human Beings, Population and Health		
Socio-economics	This section should be read in conjunction with **Tables 18.13** and **18.14** in **Chapter 18, Human Beings, Population and Health,** which detail specific measures proposed for potential socio-economic impacts. Many of these measures have been included in the design of the proposed road development. These include the provision of crossing facilities at the Foraí Maola Road, Troscaigh Road, Bearna to Moycullen Road L1321, Cappagh Road and Ballymoneen Road junctions to facilitate pedestrian and/or cyclist crossings of the proposed road development. Pedestrian crossing facilities are also proposed at the terminus of the N59 Link Road North Junction at the N59 Moycullen Road (Bushypark Junction) and at the slip road connections with the N84 Headford Road Junction. Cycle lanes are proposed to facilitate access to the Miller's Lane pitches and Gort na Bró and at the N84 Headford Road Junction. The following specific mitigation measures are proposed to improve journey amenity and minimise severance: • Provide pedestrian crossing facilities at junctions with minor roads serving local rural communities • Provide temporary visual screening from construction works at St. James' Church cemetery in Bushypark and at St. James' School, Bushypark • Provide pedestrian crossing facility at Bushypark Junction with N59 Link Road North during construction and operation • Avoid any prolonged severance and minimise duration of use by construction traffic of An Seanbóthar • Provide for alternative access along the bank of the River Corrib, along with prior advice for walkers, if access restrictions apply due to construction of the overhead bridge crossing • Phase construction works to minimise impacts on racing events at Galway Racecourse • Provide directional signage for access to the car dealership and An Post Sorting Centre on N83 during construction • Provide pedestrian crossing facilities at N84 Headford Road Junction during construction and operation • Provide a footpath within the proposed development boundary along School Road, Castlegar • Provide directional signage for a Briarhill Business Park, including a car dealership located here during both the construction • Take measures to ensure that cul-de-sacs or adjacent lands are not used for illegal parking in the operational phase Material Assets Non-Agriculture above outlines the proposed mitigation measures for the NUIG Sporting Campus facilities and Galway Racecourse.	There will be a significant residual impact as a result of the demolition of 44 dwellings and further acquisition of dwellings on those involved in the compulsory purchase process but also the integrity of the communities left behind in terms of their identity. There will also be a signification residual impact on the two building providers which are to be acquired. Material Assets Non-Agriculture above outlines the residual impacts on NUIG Sporting Campus and Galway Racecourse.
Irish Language	Mitigation measures proposed to protect the Irish Language are as follows: • During construction, all public notifications and all public project updates are provided in both Irish and English languages.	No likely significant residual impact.

Source / Scale of Effect	Control and Mitigation	Significant Residual Impacts
	• While it is expected that day-to-day communications involved in the construction of the proposed road development will be through the English language, the Main Contractor shall have the capacity to communicate and correspond through the use of the Irish language and to devote adequate and proportionate staff resources to dealing with any individual wishing to correspond and communicate through the Irish language.	
Human health	In the event of an approval of the Protected Road Scheme and Motorway Scheme and approval under Section 51 of the Roads Act 1993 (as amended), by An Bord Pleanála and subject to the availability of funding, Notice to Treat will be served firstly on owners, lessees and occupiers of the dwelling houses and commercial properties to be acquired, within six months of the scheme becoming operative, unless an application has been made for Judicial Review, in which case the Notice to Treat will be served in accordance with the provisions of Section 217 (6A) of the Planning and Development Act 2000 as inserted by the Compulsory Purchase Orders (Extension of Time Limits) Act 2010. Compensation will be agreed or determined by the property arbitrator as soon as possible after service of Notice to Treat. After compensation has been agreed or determined and satisfactory title has been produced, part payment can be made while the claimant remains for an agreed period in the property to be acquired. This will facilitate the claimant in removing uncertainty and will facilitate arrangements being made, as early as possible, to secure a replacement property. Mitigation measures proposed for the potential air quality, noise, water and soils are specified above in the respective sections. The implementation of these mitigation measures, emissions including air and noise will be adequately controlled to ensure no adverse effect on human health.	Likely significant residual impacts on those whose properties are to be acquired or demolished are as above for socio-economic.

20.3 Operational Phase

Table 20.2 below sets out the mitigation measures proposed for each environmental factor along with the significant residual impacts and their environmental consequence for the operational phase of the proposed road development.

Table 20.2: Assessment of Potential Impacts and Mitigation Measures – Operational Phase

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
Traffic		
	The traffic modelling indicates that for the Opening (2024) and Design (2039) Years there are no traffic impacts of major significance and therefore no mitigation measures are required.	The proposed road development will provide benefits to existing and new public transport services and walking and cycling routes on the adjoining local and regional road network and other measures proposed by the Galway Transport Strategy. No likely significant negative residual impact.
Waste Management		
Maintenance	There will be small quantities of operational waste likely to be generated from the proposed road development which will be delivered to authorised waste facilities in accordance with the Waste Management Acts 1996 to 2016.	No likely significant residual impact.
Biodiversity		
Designated Areas for Nature Conservation	**European Sites and Natural Heritage Areas and proposed Natural Heritage Areas** In addition to the construction measures proposed to minimise significant residual impacts on European Sites and Natural Heritage Areas and proposed Natural Heritage Area, the following measures for the operational phase are also proposed. Refer also the NIS in relation to European Sites: • Habitat degradation – hydrogeology: mitigation measures to avoid habitat degradation in Lough Corrib cSAC as a result of potential hydrogeological impacts during operation • Habitat degradation – non-native invasive species: mitigation measures to avoid the introduction or spread of non-native invasive species to European sites and Moycullen Boys NHA during operation. These are detailed in the Non-native Invasive Species Management Plan which forms part of the CEMP in **Appendix A.7.5** • Barrier effect: mitigation measures to avoid the proposed road development restricting Otter movement within the Bearna Stream catchment Mortality risk: mitigation measures to remove the risk of Otter being killed/injured due to collisions with road traffic	No likely significant residual impacts.
Habitats	Areas of Annex I habitat within the proposed development boundary which are identified to be retained and fenced off during the construction of the proposed road development will also be avoided during the operational phase. There will be no fencing within Annex I habitats that are located within Lough Corrib cSAC. Areas of compensatory habitat, including the habitat planting as part of the species mitigation measures for the construction phase will be maintained and monitored during the operational phase and remediation works undertaken if deemed necessary. Refer also to the section below in relation to Compensatory Measures.	No likely significant residual impact.
Measures to Protect Groundwater Quantity and Groundwater Quality and potential impacts on biodiversity receptors	The mitigation measures to protect groundwater quantity and quality during operation are detailed below for Hydrogeology and in turn protect many of the biodiversity receptors.	No likely significant residual impact.
Measures to Control and Prevent the Spread of Non-native Invasive Species	The mitigation strategy in relation to non-native invasive plant species which will protect many biodiversity receptors is as per that outlined above for the construction phase. These are detailed in the Non-native Invasive Species Management Plan which forms part of the CEMP in **Appendix A.7.5**	No likely significant residual impact.

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
Rare and Protected Plants and Species	As there are no rare or legally protected plant species present within the ZoI of the proposed road development they will not be affected. Therefore, no mitigation measures are required.	No likely significant residual impact.
Otters	**Habitat Severance/Barrier Effect and Collision Risk** Otters use many of the watercourses crossed by the proposed road development. To avoid Otter road casualties, Otter passage facilities will be provided at all watercourses used by Otter (e.g. raised ledges within structures, or separate dry 600mm pipes installed adjacent to culverts). Mammal underpasses will be constructed in accordance with the Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes (National Roads Authority, 2008c). The locations where Otter passage facilities will be provided are listed in **Table 8.36** of **Chapter 8, Biodiversity** and are shown on **Figures 8.23.1** to **8.23.14**. Mammal-resistant fencing will be required to prevent Otter accessing the proposed road development and to guide Otters to the mammal underpasses. Mammal-resistant fencing will be installed in accordance with the specification outlined in Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes (National Roads Authority, 2008c) and TIIs mammal resistant fencing specification (currently CC-SCD-00320/00319). The locations where mammal-resistant fencing is to be installed are shown on **Figures 8.23.1** to **8.23.14**. In accordance with the recommendations described in the Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes (National Roads Authority, 2008c), quarterly monitoring of the effectiveness of the mitigation measures will be undertaken in the first year after the completion of construction works (for example, fencing inspections to check for gaps and underpass inspection to check for blockages)	No likely significant residual impact.
Bats	**Measures to reducing mortality risk and barrier effects within the design and operation of the proposed road development** The mitigation to address significant barrier effects has been designed to reflect current best practice. The two main approaches employed for the proposed road development include underpasses of a suitable size where the design of the proposed road development is on embankment and a wildlife overpass where it is in cut. These two measures are the only options that have been demonstrated to be effective at a population level (CEDR, 2016, (Elmeros and Dekker, 2016, Abbot et al 2012a, 2012b). Underpasses are proposed in important crossing point areas and are aligned with existing landscape features that are known to be used by bats as a result of the surveys. Underpasses in the Menlough - Bóthar Nua area and N84 Headford Road areas are regarded to be of critical importance for Lesser horseshoe bat and other bat movements across this landscape. **Table 8.35** of **Chapter 8, Biodiversity** sets out the schedule of structures which provide bat passage and states the function that they serve in terms of mitigating the potential barrier effect. The size and location of the underpasses and culverts took into account the research carried out by Abbott (2012a, b) and the advice provided in the CEDR, COST341 and WC1060 reports. Refer also to **Figures 8.23.1** to **8.23.14**. In addition to the structures specifically designed for bat passage, there are other structures such as where minor roads pass underneath the proposed road development which will be used by bats as safe crossing points. The section from the N84 Headford Road to N83 Tuam Road is almost entirely in cut and installing underpasses is not possible, therefore the only effective option is a wildlife overpass (referred to throughout this report as the Castlegar Wildlife Overpass). The Castlegar Wildlife Overpass is a critical component of the strategy. It will allow bats to fly across the proposed road development between the roosts and foraging habitats on the north side and Coopers Cave and foraging areas to the south at this location. A width below 20m is not recommended as although evidence shows that species will still use these bridges, the frequency of use is reduced. The proposed overpass at Castlegar is therefore 30m wide. The proposed planting design comprises of a double hedgerow in the middle section of the overpass (to mimic a 4m wide bóithrín). Each of the hedgerows will then diverge out to create a “mouth" at the entrance to the overpass on both sides of the proposed road development to funnel bats in to the centre of the overpass. No lighting will be provided at or on any of the structures which have been designed to provide bat passage, with the exception of S06/01 where lighting will be provided to allow for safe use by pedestrians. All of the bat underpasses (as well as artificial roosts) that are designed for Lesser horseshoe bats will have connecting woody vegetation features. Other bats species are not as reliant on hedgerows and woodland edges. Whilst there are many existing landscape features outside of the proposed development boundary, the bat mitigation strategy cannot rely on these in the long term as they may be subject to interventions by third parties. In effect, what will be created is a hedgerow corridor leading up to underpasses in the section of the proposed road development between Aughnacurra and Castlegar. This planting provides a guaranteed green corridor connecting up the underpasses/overpasses and will allow bats to adapt more easily to any future landscape scale losses of connecting habitat features. The hedgerow planting leading up to underpasses will be maintained and the growth of the hedgerow monitored for 5 years following completion and remediation works undertaken if deemed necessary **Proposed monitoring programme** As the baseline level of bat activity and roost occupancy can change over time, pre-construction monitoring will be carried out in advance of construction works commencing to ensure that the data against which the post-construction monitoring will be compared to is as up-to-date as possible. Monitoring of the effectiveness of the bat mitigation and compensation measures will also be undertaken during and post-construction. Where the monitoring identifies issues with either the mitigation or compensation measures (e.g. light spill affecting usage), these will be remediated to ensure that those measures will achieve their aims with respect to mitigating or compensating for impacts on the local bat populations. Refer to the Construction section above in relation to **Pre-construction monitoring**. ***During and Post Construction Monitoring*** <u>Roost Monitoring</u>	Significant residual impacts will still remain following the implementation of the mitigation measures as some of the activities are unavoidable and can only be mitigated to a certain level of certainty. These are the same as those outlined above for the construction stage. These residual impacts have been addressed further by the proposal for specific compensatory measures noted in **Section 20.4.2** below.

<table>
<tr><th>Source/Scale of Effect</th><th>Control and Mitigation</th><th>Significant Residual Impacts</th></tr>
<tr><td></td><td>Monitoring of occupancy of the artificial roost buildings (including retrofitted retained buildings) and bat boxes will commence immediately after their installation to determine how soon they are used. They will be installed prior to the main site clearance phase; therefore, all monitoring can be by visual inspection according to the following schedule:
• Emergence counts at Menlo Castle roost: emergence counts will be undertaken during the construction works and in 5 years following construction in May, July and August. These counts will be made using infra-red video camera recording at the same time as visual inspections of bats using the proposed new roost site adjacent to Menlo Castle in order to get an overall count of bats at this location
• Artificial roost buildings: Occupancy of the proposed artificial roost buildings (including retrofitted structures) during the works and post-construction will be undertaken in the 5 years following completion of construction. Surveys will be undertaken in mid-winter for hibernation use and in May and July for use during breeding season. Surveys will include checks for individuals and also for droppings (where necessary using DNA analysis). Droppings will be removed after each check to ensure that the subsequent survey only records usage in the interim period. The roosts will be monitored annually for Lesser horseshoe bats and counts sent to the NPWS as part of the national Lesser horseshoe bat monitoring programme. This monitoring may be undertaken by NPWS staff, Galway bat group or others to be decided by the local authority. Remote modes of monitoring using new technology may mean that visits to the roosts are not always required and that infra-red images inside the roost can be sent wirelessly. Should the monitoring of the roosts suggest that bats are not using them, additional focused surveys will be undertaken to try to understand bat movements in the locality and aim to address any issues. Any changes that may be deemed necessary will be coordinated and communicated to ensure that they do not conflict with any of the impact predictions or mitigation measures prescribed in this report. Temperature and humidity probes coupled with data loggers will be installed in the roosts for two years post construction of the roost and measures taken (e.g. fitting vents, increasing period of water tanks in the hibernation roost area) to address any issues arising
• Bat boxes: The authors are not aware of any minimum or recommended standard for bat box monitoring. After installation, boxes will be visually inspected quarterly per year for the first two years. Research into the effectiveness of mitigation measures has indicated that occupancy of bat boxes averages 50% since bats may prefer existing alternative roost sites in the locality. Any boxes not showing signs of occupancy after that time may be relocated to alternative locations within the proposed development boundary nearby where they may be of benefit to the local bat population. In years 3-5 after installation the boxes will be checked in late March and September to record usage in winter and summer and to avoid disturbance during the sensitive hibernation times
• Bat boxes will be checked for a minimum of 5 years after erection

<u>Monitoring crossing points</u>
Monitoring will comprise acoustic detector and infra-red camera recording at the culverts at the five locations previously surveyed pre-construction, namely:
• Area 1: North of Bearna Woods
• Area 2: Aughnacurra
• Area 3: River Corrib to Bothár Nua
• Area 4: West of N84 Headford Road
• Area 5: Ballindooley to Castlegar, including the Castlegar Wildlife Overpass
This will quantify the usage by bats compared to non-usage (e.g. using other flight paths). This will allow a determination as to whether the bat passage structures are being effective at a population level (where it is assumed that 90% of the bats are able to pass underneath the proposed road development). Monitoring will be repeated at all locations to provide a robust dataset. In the event that the proposed bat passage structures including the Castlegar Wildlife Overpass are not deemed to be effective, then further focused surveys will be required to determine the causes and address them in a reasonable manner where possible (for example, controlling lighting, addressing local landscape changes). Any changes that may be deemed necessary will need to be coordinated and communicated to ensure that they do not conflict with any of the impact predictions or mitigation measures prescribed in this report.
In accordance with CEDR (2016) guidance it is proposed that this post-construction monitoring involves a minimum of two separate surveys in the breeding season and two separate (in time) surveys in mid-August to late-September, to reflect periods of landscape-scale movements, and that these surveys take place for two bat activity seasons (May-August) following completion of the construction of the proposed road development.
The monitoring programme described above also relates to the compensation measures for bats described in Section 8.9.2 of Chapter 8, Biodiversity and repeated below in Section 20.4.2.
<u>Diversity and abundance adjacent to the proposed road development corridor</u>
Transects of bat activity will be taken across the same locations as the pre-construction transects in order to identify any displacement effects caused by disturbance impacts during construction and operation. Whilst the application of the Berthinussen & Altringham (2015) methodology is not without its limitations as it has only been applied to open agricultural landscapes, it is nevertheless a foundation for a reproducible survey method that is appropriate to the proposed road development. If a displacement effect is detected (decreased abundance and diversity close to the proposed road development) then further focused surveys will be required to determine the causes and address them where possible (for example, controlling lighting, addressing local landscape changes through additional planting). Any changes that may be deemed necessary will need to be coordinated and communicated to ensure that they do not conflict with any of the impact predictions or mitigation measures prescribed in this report. It is proposed that monitoring takes place during construction and two bat activity seasons following completion of the construction of the proposed road development</td><td></td></tr>
<tr><td>Badgers</td><td>Habitat Severance/Barrier Effect and Mortality Risk
Badger passage facilities provided at locations listed in Table 8.36 of Chapter 8, Biodiversity and shown on Figures 8.23.1 to 8.23.14 will protect badgers during the operational phase.</td><td>No likely significant residual effect on Badger, at any geographic scale.</td></tr>
</table>

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
	A number of the mammal passage structures lie within the modelled light spill zone and artificial lighting may affect their usage by Badger: structures C07/04, C07/01(b) and C12/01. Screening will be provided to ensure that the approaches and entrances to these structures are unaffected by light spill. Mammal-resistant fencing will be required to guide badgers to the underpasses and will be installed in accordance with the specification outlined in *Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes*, and TIIs mammal resistant fencing specification (currently CC-SCD-00320/00319), and will include badger proofing of emergency access roads and other similar access points, where located in areas where mammal-resistant fencing is to be installed. The locations where mammal-resistant fencing is to be installed are shown on **Figures 8.23.1** to **8.23.14**. In accordance with the recommendations described in the *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes* (National Roads Authority, 2006), quarterly monitoring of the effectiveness of the mitigation measures will be undertaken in the first year after the completion of construction works. (for example, fencing inspections to check for gaps and underpass inspection to check for blockages)	
Other mammal species (excluding bats)	***Habitat Severance/Barrier Effect*** The combination of the network of dedicated mammal passage facilities, along with the bridge and viaduct structures (the proposed River Corrib Bridge and the Menlough Viaduct), and the retained lands above the proposed Lackagh Tunnel and the Galway Racecourse Tunnel provide a high degree of landscape permeability along the proposed road development for all of the other mammal species recorded, or likely to be present, with the study area. The locations are described in **Table 8.36** of **Chapter 8, Biodiversity** and shown on **Figures 8.23.1** to **8.23.14**. Wildlife passage facilities have been shown to be used by small mammal species such as Hedgehog, Pygmy shrew and Wood mouse (Dolan 2006; Eldridge & Wynn 2011); although their effectiveness has not been tested. However, it is likely that the high permeability of the proposed road development will reduce the effects of any severance, barrier effect or collision risk that may be associated with the proposed road development (Haigh, 2012) such that the species' conservation status would not be affected.	No likely significant residual effect on any other mammal species (excluding bats), at any geographic scale.
Invertebrates	**White-clawed crayfish & Freshwater pearl mussel** As there are no impacts, no mitigation measures are required. **Marsh whorl snail** ***Habitat Degradation – Groundwater*** The mitigation measures relating to the protection of the groundwater resource during operation are described below for Hydrogeology. **Marsh fritillary** No likely significant negative effects on Marsh fritillary are predicted during operation and no mitigation measures are required.	**White-clawed crayfish & Freshwater pearl mussel** No likely significant residual impact. **Marsh whorl snail** No likely significant negative residual impact on the Marsh whorl snail, at any geographic scale. **Marsh fritillary** No likely significant negative residual impact on the Marsh fritillary butterfly, at any geographic scale.

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
Birds	**Breeding Birds** ***Habitat loss, Habitat Severance/Barrier Effect and Mortality Risk*** Planting of woodland, hedgerow and grassland habitats along the proposed road development as detailed in the landscape drawings (**Figures 12.2.01** to **12.2.14**) will provide compensatory habitat for some bird species. In some instances, such as in large areas of improved agricultural grassland with no vegetated field boundaries, this will improve the diversity of bird habitat. Many species may not nest near a road development due to disturbance (e.g. drowning out of bird song by traffic noise). Whilst the planting is not likely to fully offset the loss of breeding habitat (due to the proximity of road traffic disturbance on the operational road) it is likely to provide additional foraging habitat for some species. To further minimise the effects of breeding habitat loss, a total of 20 nest boxes will be erected by a qualified ecologist in suitable locations away from the busy junctions/roadways. The siting and type of nest boxes will be decided on by an ecologist at locations where trees will be planted or retained along the proposed road development; as shown on **Figures 12.2.01** to **12.2.15**. ***Barn owl*** Sections along the proposed road development will be planted with dense low growing scrub cover (e.g. blackthorn) to discourage Barn owls from foraging near the proposed road development. The planting will be of a density to minimise the lag time between planting and obtaining sufficient ground cover to deter foraging Barn owl. In areas where there is a high probability that Barn owls may regularly attempt to cross the proposed road development (the section of embankment between Ch. 9+600 and Ch. 10+100), lines of closely spaced (approximately 2m centres) trees, greater than 3m in height, will be planted along the top of the embankments of the proposed road development; outside of the safety barrier and clear zone. The understorey will also be densely planted. This is to present a solid vegetated barrier to deflect Barn owl from these high-risk areas and/or force birds to fly over the proposed road development above the road traffic. All mitigation planting will be in place at the earliest feasible stage during construction to ensure that the mitigation is functioning as soon as possible, following the opening of the proposed road development. The locations where planting will be used to reduce the risk of Barn owl mortality from road traffic are shown on **Figures 8.23.1** to **8.23.14** and on the landscape drawings (**Figures 12.2.01** to **12.2.14**). The following monitoring measures are proposed: • Surveys will be undertaken of roadside planting at the end of years one and two with the objective of identifying and replacing failed plantings. • A road casualty survey to record barn owl mortalities along the route of the proposed road development will be conducted once per week for a period of two years by a suitably qualified and experienced ornithologist. The proposed road development will be driven at a steady pace in both directions so that all sections and both sides of the route will be surveyed correctly. Where noted, all barn owl mortalities will be assigned to either the "breeding" season (March to July) or "non-breeding" season (August to January). Location details of the casualty will be recorded, including a 10-digit GPS co-ordinate, position on the route (central median, hard shoulder, or verge) and orientation (southbound, northbound, eastbound, and westbound). The age class of the bird will be determined and classed as either "pre-breeding" if first or second calendar year recovered before March, or "adult" if the bird is second calendar year recovered later than March or older. The adjacent habitat feature will be noted. This methodology is in line with that utilised for *Barn Owl population status and the extent of road mortalities in relation to the Tralee Bypass* (O'Clery et al., 2016); • Monitoring to determine activity and breeding status of all active sites within 5km of the proposed road development over two breeding seasons (March to July). This will be carried out concurrently with the road casualty survey, and will involve visits to known and potential nesting sites to determine brood size and breeding success. Where accessible, nests will be visited in order to ring owlets (subject to an appropriate licence from the NPWS). A report summarising the findings of the above monitoring will be submitted at the end of year two to the NPWS. The report may include further recommendations pending survey outcomes. **Wintering Birds** **Measures to Protect Wintering Birds during Operation** ***Disturbance/Displacement*** Despite the assessment conclusion that disturbance during operation of the proposed road development is not likely to result in any population level effects on wintering birds, hedgerow planting along the proposed development boundary (at the locations shown on the landscape drawings (**Figures 12.2.01** to **12.2.14**) will further minimise the potential disturbance to wintering birds from road traffic.	**Breeding birds** No likely significant residual effect on breeding bird species, at any geographic scale, with the exception of the Peregrine falcon. Due to the likely permanent loss of Lackagh Quarry as a nesting site, the proposed road development is likely to result in a significant negative residual effect on Peregrine falcon, at the county geographic scale. **Wintering birds** No likely significant residual effect on wintering bird species, at any geographic scale.

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
Amphibians, Reptiles	**Measures to Protect Amphibians during Operation** ***Habitat Severance & Barrier Effect*** The combination of the network of wildlife passage facilities, culverts, bridges and viaduct structures (e.g. the proposed River Corrib Bridge and the Menlough Viaduct) provide a high degree of landscape permeability along the proposed road development. This will serve to maintain connectivity at a local scale between sites used by amphibian species and is predicted to reduce any long-term severance or barrier effects associated with the proposed road development such that the conservation status of amphibian species is not likely to be negatively affected. The locations are described in **Table 8.36** of **Chapter 8, Biodiversity** and shown on **Figures 8.23.1** to **8.23.14**.	No likely significant residual effect on the Common frog or the Smooth newt, Common lizard, at any geographic scale.
Soils		
Lackagh Tunnel	During the operational phase, monitoring of the rock mass stability will continue. The rock and overburden retaining systems in Lackagh Quarry and Western Approach will continue to be monitored as part of the TII (Transport Infrastructure Ireland) maintenance schedule. In the extremely unlikely event that instability within the rock mass is observed additional support measures outlined above **Sections** Error! Reference source not found. and Error! Reference source not found. of **Chapter 9, Soils and Geology**, for the construction phase will be installed to ensure that there is no impact to the structural integrity of the Limestone pavement. However, based on the conservative design approach, (the installed composite support system and monitoring during construction) it is considered that the risk of instability will be avoided and additional support measures will not be required. Operation mitigations measures for Lackagh Tunnel are further discussed in **Appendix A.7.3**. The implementation of the design, construction methodology control measures and mitigations measures results in no other operational phase mitigation measures for avoiding potential direct and indirect impact to the soils and geology environment for the proposed road development.	No likely significant residual impact.
Hydrogeology		
Groundwater Quantity and Quality	During the operational phase of the proposed road development inspection and maintenance will occur to ensure that the infiltration basins continue to operate as intended for the design life of the proposed road development. Infiltration basins will be inspected regularly to confirm that no observable subsidence in the infiltration has occurred due to karst. There are no guidelines on the inspection frequency for infiltration basins, however, based on the mitigation measures implemented the risk of subsidence occurring is considered to be low and inspection is recommended on 5-year frequency. If karst features and potential pathways are found to be present during inspection, then the Karst Protocol developed for the construction phase will be implemented to ensure that no preferential pathways have formed within the infiltration basin.	Residual hydrogeological impacts remain for groundwater level drawdown impacts below the location of five Annex I habitats on the Galway Granite Batholith noted above for the construction stage.
Hydrology		
Flood Risk	The proposed design flood level for the relief measures at the N83 Tuam Road include for the 100 year return period flood event with a 20% allowance for climate change is 17.5m OD Malin which will prevent flooding of the driveways to the dwellings and the N83 Tuam Road. The flood relief mitigation measures to eliminate the flood risk of the proposed road development and reduce the existing flood risk in this area are described above in **Table 20.1** for hydrology. To minimise the residual flood risk associated with the blockage of flood relief culverts and associated drainage assets, the following operational mitigation measure is recommended: • Regular (monthly) inspection of N83 Flood Relief facilities be carried out to ensure that the system is in proper working order and performing as designed.	The will be no likely significant residual negative hydrological impacts on drainage and general flood risk, water quality, channel morphology or key ecological receptors. As noted above in **Table 20.1** under Hydrology, there will be a significant positive residual impact on the N83 Tuam Road flood risk. However negative slight residual flood impacts associated with the N83 flood relief measures noted in **Table 20.1** will remain.
Landscape and Visual		
Project-wide Landscape Measures	Measures proposed to mitigate the landscape and visual impacts of the operation stage of the proposed road development are considered under Project-wide Measures and Specific Measures. **Project-wide measures** are outlined below and shown on **Figures 12.4.01** to **12.4.14** of **Chapter 12, Landscape and Visual** • Cut slopes on mainline, link roads and local roads	During the initial operation stage landscape and visual impacts will continue to arise from the physical presence and operation of the proposed road development. The proposed road development will be a significant and prominent new element in the landscape – at least until such stage as landscape mitigation proposals establish and become increasingly effective.

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
	○ Cut slopes shall be finished to even gradients, topsoiled unless otherwise stated in this table or elsewhere in the EIAR. Slopes shall be free of rubble and stones over 50mm diameter. All such rubble/stone shall be removed or buried. Unless otherwise stated slopes shall be seeded to a low maintenance non-agricultural grassland or to a diverse grass/wildflower sward, as appropriate. Steep slopes may be hydro-seeded. ○ Where exposed, stable rock cuttings/slopes will be retained as a landscape feature along the proposed road corridor. • Embankments on mainline, link roads, and local roads ○ Embankments shall be finished to even gradients, topsoiled unless otherwise stated in this table or elsewhere in the EIAR. Slopes shall be free of rubble and stones over 50mm diameter. All such rubble/stone shall be removed or buried. Unless otherwise stated slopes shall be seeded to a low maintenance non-agricultural grassland or to a diverse grass/wildflower sward, as appropriate. Steep slopes may be hydro-seeded. • Verges & Roundabouts on mainline, link roads, and local roads ○ Verges will be provided along both sides of mainline. Verges will also be provided around junctions and along local road re-alignments and tie-ins. Verges and roundabouts shall be finished to even or gently flowing gradients, with minimum 200mm topsoil. Areas shall be stone buried or raked will be free of rubble and stones over 25mm diameter. Verges and roundabouts will be seeded to low-maintenance seed mix. • Ponds, swales, 'V-drains' etc. ○ All slopes shall be evenly graded and free of rubble and stones over 50mm diameter. Slopes shall be seeded to low maintenance non-agricultural grassland or to a grass/wildflower sward, allowing for natural development over time. Steep slopes on pond edges and 'V-drains' may be hydro-seeded. ○ Areas around ponds shall be a diverse landscape of low maintenance grassland/species-rich grass wildflower sward and plantings of scrub planting and/or low-canopy woodland and shrub planting. Hedgerows of blackthorn and hawthorn, hazel and holly, without tree species, shall be established along non-roadside boundaries. ○ Non-palisade type fencing (e.g. paladin or timber and anti-climb netwire fencing) shall be installed to secure pond areas. • Noise barriers/bunds ○ Where possible hedgerow scrub and shrub planting and/or low-canopy woodland of native species shall be established as either a narrow planting of 3.0m minimum width or double-staggered hedgerow along the full off-road face of barriers. ○ Low-canopy and/or shrub planting of native species shall be established on the off road face of bunds. The planting shall include ash*, birch, blackthorn, elder, hawthorn, hazel, holly, rowan and/or willow species as appropriate. Plants shall be 90 to 120cm in height at planting. *** Note**: Due to the risk of Ash Dieback (*Chalara fraxinea*) and until further notice, ash (*Fraxinus* species) is no longer approved by the TII for planting schemes. This does not impact on the use of Mountain ash – also known as rowan (*Sorbus aucuparia*). ○ Transparent noise barriers will be used on the River Corrib Bridge • Plants and planting areas ○ All tree species over 150cm in height together with all Pine shall be appropriately staked and tied. All failed, dead or defective plants shall be replaced before the end of each and every year of defect aftercare. ○ Full planting area will be free of stones over 50mm in diameter. • Grass areas ○ Grass areas shall provide full sward cover within 12 months of seeding. Any failed, bare or defective areas shall be re-seeded between March – May and/or August – September in each and every year of defect aftercare. • Unauthorised access, parking and/or encampment ○ Landscape proposals shall avoid creating areas considered as being suitable for unauthorised parking and shall use landscape proposals to deter and prevent such use. • Remnant areas ○ Any post-construction remnant lands shall be treated to a diverse range of grassland and/or planting proposals to include a minimum 30% planting, amended as locally appropriate. The remaining area shall be treated as locally appropriate low maintenance grass/species-rich sward. The above project-wide measures will be applied over the entire proposed road development, depending on the nature of the particular road section. Where feasible landscape measures shall include for the re-connection of existing field boundaries and hedgerows along the proposed road development. Where appropriate trees species as noted above and in **Tables 12.8** of **Chapter 12, Landscape and Visual**, shall be randomly spaced in a visually naturalistic manner within such hedgerows. This approach will be locally modified to incorporate other landscape treatments, which may negate the requirement for the hedgerow, *e.g.* blocks of native woodland planting (see Landscape Guidelines, Section 6.2: Tree and Shrub Treatments) or semi-natural meadows (see Landscape Guidelines, Section 6.1: Grassland Treatments) where it is considered appropriate	As such, initial operational-stage landscape and visual impacts will continue to be pronounced and negative in the short-term (*i.e.* pre-establishment stage). With the development of mitigation planting, the significance and severity of landscape and visual impacts will gradually abate over time. Negative visual impact will also continue to arise for residential and other properties located close to or adjoining the boundary of the proposed road development for some time (*i.e*. post-establishment stage). Therefore, significant or notable residual landscape impacts will continue to arise: Along the edge of Sruthán Na Libeirtí, Bearna On the open elevated landscapes of Ballagh, Rahoon, Letteragh, Barnacranny and Dangan Upper On the recreation sports and amenity landscape of NUIG Sports Campus On the lowland landscape valley of the River Corrib, and the setting of Menlo Castle On the limestone landscape of Menlough and Coolough On the rolling landscape through Castlegar, south of Ballindooley Lough Locations of these significant landscape impacts are provided on **Figures 12.4.01** to **12.4.14**. Significant or notable residual visual impacts will continue to arise for properties: At the crossing of local roads north and northeast of Bearna (Foraí Maola Road, Troscaigh Road, Ann Gibbons Road, Aille Road) At the crossing of local roads northwest of Galway (Cappagh Road, Ballymoneen Road, Rahoon Road and Letteragh Road) To either side of the crossing of the N59 Moycullen Road north of Galway (The Heath, Barnacranny, Ard na Locha, Aughnacurra and at Bushypark/Ballagh) On the recreation sports and amenity landscape of NUIG Sports Campus On the lowland landscape valley of the River Corrib, and setting of Menlo Castle At the crossing of Bóthar Nua and Seanbóthar north/northeast of Galway City At the crossing of the N84 Headford Road, at Castlegar, (including crossing of School Road) and at the N83 Tuam Road, northeast of Galway

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
	to have open sections along the proposed carriageway. Open sections shall allow for views to the wider landscape where they do not impinge on requirements for screening for residential properties or other amenities. Proposals will ensure that planting is distributed along the proposed road development and the associated local road realignments and will vary from locally appropriate hedgerow reinstatement, with tree-planting, where appropriate; to wider plantings of landscape and screen planting; to the establishment of larger areas of scrub/shrub planting and new woodland for integration of the development within the wider landscape. The approach will provide a density and diversity of plantings and improve the biodiversity structure of the new landscape (see Landscape Guidelines, Section 6.2: Tree and Shrub Treatments). Treatments will take into consideration the assessment and recommendations of the mitigation measures described in the Biodiversity section and will ensure that, species which are locally indigenous and native are utilised in the proposed plantings. However, detailed proposals in terms of their nature and approach will consider the locally impacted environment and in terms of species may include non-invasive, non-native plants, *e.g.* within residential areas where existing garden plantings are disturbed. Where areas are in cut or fill, a grass or meadow sward will be established over the slope except in areas of cutting through stable rock (see Landscape Guidelines, Section 4.2: Cuttings and Embankments). Except where otherwise required, it is not proposed to plant either cut or fill slopes in their entirety, but to encourage a more naturalistic and locally sympathetic grouping of plantings within a semi-natural grass sward. Slopes may also be seeded to wildflower grassland and hydro-seeding may be utilised for seeding of steep slopes. It is expected that significant extent of rock cutting will arise on the proposed road development. Stable rock slopes will be retained as an exposed face for natural colonisation and as a local landscape features. Along the length of the proposed road development, landscape areas within junctions and small areas of severed fields, plots or other property acquired for the construction of the proposed road development will be varyingly treated including being planted in a semi-natural copse like scrub plantings and native woodland species (see Landscape Guidelines, Section 4.6: Additional Plots and Other Areas). Such planted blocks dispersed along the proposed road development will assist in the improvement of the longer-term visual character of the proposed road development and local surrounds. Particular attention shall be given to an appropriate extent and scale of planting in and surrounding junctions (see Landscape Guidelines, Section 4.3: Junctions, Interchanges and Roundabouts) and embankments (see Landscape Guidelines, Section 4.2.2: Embankments). Certain areas along the length of the proposed road development have been set aside for drainage requirements/pollution control/attenuation. Where proposed these will be securely fenced and planted with locally appropriate hedgerows, shrubs and/or screen planting located along the proposed development boundary to minimise any visual impact from off road areas. However, it is noted that these features also offer the potential to provide for improved landscape diversity and habitat. Proposed planting will generally be established using bare-root transplants, whips and feathered plants which adapt readily to disturbed ground conditions. A proportion, totalling not less than 5% of ‘Half-standard’ (6-8cm girth & 200cm-250cm tall) and a further 5% ‘Standard’ (8-10cm girth & 250cm-300cm tall) trees shall be used to supplement these plantings, especially in the vicinity of residential areas. All planting mixes will take cognisance of, and include native and local species as identified in the **Chapter 8, Biodiversity**. These requirements have been adapted and further detailed as appropriate to particular areas as set out in **Table 12.8** of **Chapter 12, Landscape and Visual**. Where used, tree species will be selected from a list of primarily native, naturalised and indigenous species, which will include alder, common ash (*subject to planting restrictions at time of works*), common birches, common oaks, mountain ash, Scots pine and willow species. Planting sizes will be from 75cm to 400cm in height and tree species will be planted at average 2.0m centres within the wider planting mix. Shrub planting species utilised will be selected from a list of primarily native and indigenous species, which will include, blackthorn, elder, hawthorn, hazel, holly, guelder rose, spindle, willows and other plants found naturalised in the affected localities. Planting sizes will vary from 30 to 75cm in height and shrub species will be planted at between 1.0 and 1.5m centres depending of landscape type, see **Table 12.8** of **Chapter 12, Landscape and Visual**. Hedge planting will be primarily of blackthorn and hawthorn interspersed with other species such as elder, hazel, holly and those found locally. Hawthorn within hedgerows shall be planted at between 75 to 90cm in height and at 500mm centres in each of 2 double staggered rows or wider plantings where a denser effect is required. The hedgerow will be interspersed with standard-sized randomly spaced tree species such as alder, common ash and oaks, as appropriate to particular locality. Areas to be seeded to meadow will be thinly topsoiled (5cm layer) and seeded with a locally appropriate seed mix. Mainline and side road verges will be cultivated, topsoiled minimum 200mm deep and stone buried to remove stones down to 25mm diameter prior to seeding to a low-maintenance grass seed mix. Where lighting is proposed, the lighting design shall meet the requirements of BS EN 13201-2:2003 and BS5489-1: 2003, Code of Practice for Design of Road Lighting. Lighting of Roads and Public Amenity Areas and shall comply with the requirements of the DMRB TD 34-91. The detailed lighting design shall be completed in a manner, which will minimise glare and will ensure that light-spill effect is minimised.	At Ballybrit/Parkmore, at Racecourse Avenue, Ballybrit Crescent, Monivea Road and Coolagh-Briarhill east of Galway
Specific Landscape Measures	In specific locations barriers and/or earth bunds may be provided to reduce the impact of noise. Such barriers will also have the effect of providing immediate visual screening of traffic from properties. Such features shall, wherever possible, be integrated within the proposed landscaping measures. The Noise and Vibration section below outlines the assessment of noise impact and the requirements for such mitigation.	

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
	Specific mitigation measures are set out on **Figures 12.4.01** to **12.4.14** and in **Table 12.8** of **Chapter 12, Landscape and Visual** which is summarised below. The measures include construction-related aspects such as avoidance/minimising impact on property boundaries and landscape features as well as provision of solid screen hoarding during the construction phase for those properties particularly impacted by the works. All of the following specific mitigation measures will be taken account of in the detailed design and implementation of landscape measures: • Location of cut-off drains at the top of cuttings and at the bottom of embankments • The location and requirements for maintenance access along the mainline of the proposed road development • Locations where rock is encountered in cuttings. Such rock faces may be retained as geological features of the corridor of the proposed road development • The location and integration of noise barriers within the landscape design • Clearance zones (TD19 - Safety Barrier Standards) • Sight-lines, including at junctions and to carriageway signage, etc. A series of significant retaining walls, and a bridge over the N59 Moycullen Road, are proposed in the Dangan area between Ch. 8+300 and Ch. 8+670. This is both an existing residential area and a gateway into the city. Where feasible reinforced earth retaining wall approaches will be incorporated so as allow for a green landscape finish to all or part of the retaining structures. A limestone finish will be used where structural walls are required and for the abutments of the proposed bridge over the N59 Moycullen Road. The stone will consist of natural limestone, matching the character of the local stone, with a strong horizontal axis of between 5 to 1 and 7 to 1 (*i.e.* horizontal to vertical dimension). Landscape Measures also take account of the specific protection and mitigation measures detailed in **Chapter 8, Biodiversity**. In particular, the measures include: • Retained habitats, trees and hedgerows on land-take boundaries, etc. will be fenced-off and protected during construction works • Specific measures are proposed at a number of locations for mitigation of potential impact on Bat species. This includes: o the provision of artificial bat roosts – with specific planting to encourage use o the provision of a planted wildlife overbridge (Ch. 12+700) with tie-in planting to local hedgerows and proposed planting on the boundary of the proposed road development, which will maximise potential benefit and use o dense planting, with trees for improvement of connectivity along the boundary of the proposed road development: o west of the crossing of the L1323 Letteragh (Ch. 7+200 – Ch. 7+280) o along embankments to either side of the proposed bridge over the River Corrib o between the crossing of the N84 Headford Road at Ballindooley and School Road at Castlegar o hedgerow planting for improvement of connectivity of habitats to the east of Menlo Castle o hedgerow and copse planting for enhancement of foraging habitat to the north of Menlo Castle • In order to deter Barn Owls from foraging close to the proposed road development, embankments and cuttings, other than rock cuttings or cut slopes left to naturally regenerate, will be densely planted with low growing scrub (e.g. blackthorn, hawthorn) from Ch. 8+550 to Ch. 17+500 • In order to deter Barn Owls from over flying the proposed road development, planting of closely-spaced trees (approx. 2m centres) greater than 3m in height will be established along the top of the embankments between Ch. 9+600 and Ch. 10+100 • All mitigation planting will take place at the earliest opportunity feasible during the construction stage so as to maximise establishment prior to road opening **Table 12.8, Specific Landscape and Visual Mitigation Elements and Treatments is outlined below**. • 6.0m wide Screen Planting: (Planting at 1.0m centres for visual screening shall be of a minimum of 6m in width. The planting shall extend for a minimum of 100m to either side of any adjoining residential property or amenity. (refer to **Figures 12.4.01** to **12.4.14**)). o Planting will include a dense planting at 1m centres of alder, birch, blackthorn, elder, geulder rose, holly, hawthorn, hazel, rowan, and willow species. Shrubs shall be planted at between 60 to 90cm in height. o Scots pine of minimum 60cm in height at planting shall comprise 20% of the overall plant numbers and holly at a minimum of 45cm in height shall comprise a further 15%. o Tree species, planted equally at half-standard (6-8cm girth) and standard size (8-10cm girth), shall comprise minimum 10% of the mix. • 3.0m wide Screen Planting: (Where space is limited planting at 1.0m centres for visual screening shall be of a minimum of 3m in width. The planting shall extend for a minimum of 100m to either side of any adjoining residential property or amenity. (refer to **Figures 12.4.01** to **12.4.14**)) o Planting will include a dense planting at 1m centres of alder, birch, blackthorn, elder, geulder rose, holly, hawthorn, hazel, rowan, and willow species. Shrubs shall be planted at between 60 to 90cm in height. o Scots pine of minimum 60cm in height at planting shall comprise 20% of the overall plant numbers and holly at a minimum of 45cm in height shall comprise a further 15%. o Tree species, planted equally at half-standard (6-8cm girth) and standard size (8-10cm girth), shall comprise minimum 20% of the mix. • Stone Wall Boundaries (Stone walls as indicated on **Figures 12.4.01** to **12.4.14**))	

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
	• Where indicated stone walls will be replaced along impacted sections of property and road boundaries on local roads. The stone from the disturbed sections of existing walls will be retained and re-used (generally granite to west; limestone to east) where possible to reinstate these new boundaries. The boundary walls may be backed by hedgerows of locally appropriate species, i.e. blackthorn, hawthorn and holly to west and hazel, hawthorn and holly to east. Elsewhere, where stone walls are removed the stone will be retained and made available for re-use by the adjacent property owners for the construction of a new stone wall on their side of the proposed development boundary if they wish. Boundary Hedgerow (Typical double staggered hedgerow with tree planting, where locally appropriate) ○ Primarily blackthorn (30%), hawthorn (40%) and holly (10%) hedgerow in west interspersed with other species (20%) such as elder, willow, and those found locally. ○ Primarily hazel (30%), hawthorn (40%) and holly (10%) hedgerow to east interspersed with other species (20%) such as blackthorn elder, willow, and those found locally. ○ Hawthorn plants shall be of c.90cm in height and planted at 50cm centres in each of two double staggered rows, 25cm apart. Other plants of c.50cm in height shall be interspersed. ○ The hedgerow may be interspersed with 'half-standard-sized' (6-8cm girth) alder, birch and/or oak trees planted at random spacings but averaging a min. of 1 tree per 25 linear metre. Limited tree species, such as birch and mountain ash may also be included as 'whips' at 150cm in height. • Retaining Walls and structure over the N59 Moycullen Road: (Use of reinforced earth retaining systems and limestone finishes for structural elements. Retaining Wall Structures R08/01; R08/02; R08/07 & R08/04; and Bridge Structure S08/02 (Ch. 8+300 to Ch. 8+670)) ○ Where feasible reinforced earth retaining wall approaches will be incorporated so as allow for a green landscape finish to all or part of the retaining structures. ○ Planting of trees shall also be provided along the base of the structure. These shall include smaller growing species such as alder, birch and rowan planted as Selected Standards (i.e. 14cm girth or greater) ○ A limestone finish will be used for the external finish of the abutments of the proposed bridge over the N59 Moycullen Road and where structural walls are required. The stone will consist of natural limestone, matching the character of local stone, with a strong horizontal axis of between 5 to 1 and 7 to 1 (i.e. horizontal to vertical dimension). • Bat habitat enhancement (New 2m wide tree and shrub hedgerow, with occasional planted copses located north and east of Menlo Castle.) ○ New hedgerow of native species will be established with plants at 0.5m staggered centres in each of 5 rows located 0.5m apart to sub-divide existing open fields. ○ Standard-sized trees species (min 8-10cm girth, 2.4m high) will be planted at 15m staggered centres in each of the 3 central rows. Diverse range of shrub species will be planted between trees in the central rows and throughout the outer 2 rows. ○ Circa 15m diameter woodland copses will be established within open fields using similar approach, densities and species. ○ Planting will be protected by stock-proof fence, c.1.25m high located at 1.0m offset to either side of the outer row of the new hedgerow. ○ Tree species to include alder, birch, oak, rowan, planted as standards (as above) and whips (1.25m high). Shrubs to comprise mainly blackthorn, hawthorn and hazel (combined 60%), with elder, holly, spindle, willow etc. ○ Hawthorn plants shall be of between c.90cm in height and all other shrubs shall be c.60cm in height. • Wildlife Overpass: (Ballindooley/Castlegar, Structure S12/02 (Ch. 12+700)) ○ Wildlife overpass (c.30m wide) will be landscaped to provide for connective habitat across proposed road development. Planting to consist of a central narrow grass path bounded on either side by tree-lined hedgerows of native species. ○ Soil depths to vary from minimum c.45cm depth at edges to c.1.5m depth along centre-line of both hedgerows. Planted element of both hedgerow lines will be c.2m wide with standard-sized trees (min 8-10cm girth, 2.4m high) planted at 3m staggered centres in each of 2 rows in each hedgerow. Diverse range of shrub species will be planted between trees and along the line of each hedgerow. ○ Planting to tie-in to proposed planting leading east and west on upper slopes of cuttings on both sides of the proposed road development. This will form a continuous hedgerow/planted network. ○ Tree species to include alder, birch, oak, rowan, planted as standards (as above) and whips (1.25m high). Shrubs to comprise mainly blackthorn, hawthorn and hazel (combined 60%), with elder, holly, spindle, willow etc. ○ Hawthorn plants shall be of between c.90cm in height and all other shrubs shall be c.60cm in height. • Barn Owl Tree Planting: (Typical double staggered treeline with dense underplanting, between Ch. 9+600 and Ch. 10+100. ○ Deterrent tree planting to comprise alder, birch and/or rowan planted at 3m in height (min 12-14cm girth) and at 2.0m centres in each of 2 rows 1.5m apart. ○ Dense low scrub planting to comprise blackthorn (50%), hawthorn (20%), hazel (10%) and holly (10%) hedgerow in west interspersed with other species (10%) such as elder, willow, and those found locally. ○ Hawthorn plants shall be of c.90cm in height and planted at 50cm centres. Blackthorn and other plants shall be of c.50cm in height and planted at 50cm centres in staggered rows, 50cm apart. • Barn Owl Scrub Planting (Dense low scrub planting on all embankments and cut slopes (other than rock cuttings or cut slopes left to naturally regenerate) from Ch. 8+550 to Ch. 17+540): ○ Dense low scrub planting to comprise blackthorn (50%), hawthorn (20%) hazel (10%) and holly (10%) interspersed with other species (10%) such as elder, willow, and those found locally.	

<table>
<tr><th>Source/Scale of Effect</th><th>Control and Mitigation</th><th>Significant Residual Impacts</th></tr>
<tr><td></td><td>Hawthorn plants shall be of c.90cm in height and planted at 50cm centres. Blackthorn and other plants shall be of c.50cm in height and planted at 50cm centres in staggered rows, 50cm apart.
Compensatory Habitat Areas: (CHA) Along Proposed Road Development: Refer to ‘CHA’ locations on Figures 12.4.01 to 12.4.14). Areas identified for compensatory habitat for mitigation of potential ecological impacts will be as outlined above for biodiversity</td><td></td></tr>
<tr><td colspan="3">Archaeology, Architectural and Cultural Heritage</td></tr>
<tr><td>General</td><td>The proposed mitigation measures for the operational phase are detailed below. These measures are proposed to mitigate the indirect impacts of the operational phase of the proposed road development on these features. It is noted that these measures will be carried out during or prior to the construction phase:
Archaeological sites, AH 15, 16, 29, 11, 12, 23 and 26 will be subject to a detailed photographic and written landscape record to preserve their current setting prior to the construction and operation of the proposed road development. This shall be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.
Protected structures, BH 1, 7, 9, 10 and 17 will be subject to a detailed photographic and written landscape record to preserve their current setting prior to the construction and operation of the proposed road development. This shall be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.
Cultural heritage sites CH 20, 23, 8, 25, 30, 35, 42 and 54 will be subject to a detailed photographic and written landscape record to preserve their current setting prior to the construction of the proposed road development. This shall be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.</td><td>Whilst the proposed mitigation measures will record the current context of those sites which will be indirectly impacted, they will not fully remove the residual impact of the proposed road development on the setting of the following sites:
AH 15/BH 19 Menlo Castle – post mitigation the operation of the proposed road development will have an indirect moderate negative impact on the castle
AH 16/BH 10 Summer House – post mitigation the operation of the proposed road development will have an indirect moderate negative impact on the castle</td></tr>
<tr><td colspan="3">Agriculture</td></tr>
<tr><td>Operational Road</td><td>The loss of agricultural land due to the construction of the proposed road development is a permanent loss which cannot be mitigated except through compensation.
Landowners who lose buildings to the proposed road development will be compensated. Compensation payments will enable farmers to replace buildings.
All separated land parcels will be accessible either via the local road network, via accommodation access roads and access tracks.
Where existing water and electricity supplies to fields or farm yards are severed, the supply will be reinstated by provision of ducting where possible. Alternatively, where ducting is not feasible a permanent alternative water source or electricity supply will be made available. Compensation payments will enable farmers to replace power and water supplies.
Landowners may have to build additional farm facilities (e.g. cattle holding and testing pens) on their separated land. Field boundaries and paddock systems may have to be re-organised to take into account the altered shape of fields. These matters are addressed in the compensation payments.
Water from the proposed road development will be diverted to attenuation ponds before discharging to watercourses or to ground. The drainage design of the proposed road development will intersect existing field drains and carry the drainage water to suitable outfalls.
Other injury impacts such as loss of shelter, removal of field boundaries, disruption of farm roads and field paddock systems and the increased potential for trespass on to private land due to the proposed road development are taken into account in this assessment. Statutory compensation will be used to compensate landowners for residual effects and to allow the landowners to execute mitigation measures and re-instatement works on their own land.
Landscaping along the proposed road development will minimise the visual impact on farms along the route of the proposed road development and will over time improve shelter in affected farms.</td><td>The 41 Significant, 8 very significant and 4 profound impacts will remain and will be dealt with as part of the land acquisition process and will be agreed at a later date with a valuer. Compensation does not form part of the EIA process and is therefore not considered further</td></tr>
<tr><td colspan="3">Material Assets Non Agriculture</td></tr>
<tr><td>Operational Road</td><td>The proposed road development will result in a 20 per cent reduction of the NUIG Sporting Campus at Dangan, due to the encumbrance caused by the viaduct support structures. This will result in the removal of two grass based GAA sized playing pitches.

As a consequence, the NUIG Sporting Campus will require a new sporting campus plan and strategy. The provision of a viaduct structure at the NUIG Sporting Campus will provide access to the north and south of the Sporting Campus and the River Corrib during the operational phase, maintaining connectivity and permeability beneath the proposed road development.
The current road which provides access to Hewlett Packard and Boston Scientific will become a through road at the operational phase of the proposed road development. The additional traffic will present new severance compared with the Do-Nothing scenario. However, a speed of 50kph will limit speeds and traffic will be generally for local access only.
The stable yard and associated facilities for Galway Racecourse will be relocated as shown on Figure 15.4.1 and detailed in Appendix A.15.2 mitigating the operational impacts on the racecourse.

Noise barriers will be provided across the length of the proposed road development to mitigate potential increase in noise as detailed in noise and vibration and shown on Figures 17.1.1 to 17.1.15.</td><td>The residual impacts from all of the very significant/significant impacts, 54 residential properties, eight commercial properties and one residential planning permission, which will be acquired and/or demolished to accommodate the proposed road development, remain as very significant/significant impacts as no mitigation is possible to reduce the impact. The residual impact post compensation cannot be assessed as the compensation to be agreed as part of the land acquisition are outside the scope of the EIA process.
The residual impact on NUIG Sporting Campus post compensation cannot be assessed as the compensation to be agreed as part of the land acquisition is outside the scope of the EIA process.
There will be a positive residual impact on Galway Racecourse once the mitigation measures have been</td></tr>
</table>

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
		constructed with the provision of enhanced access to the premises and a new stable yard.
Air and Climate Change		
Air Quality	As it is predicted that all air quality standards for the protection of human health and vegetation will be complied with, no specific mitigation measures are required.	No likely significant residual impact.
Climate	The *Transport Infrastructure Ireland Environmental Impact Assessment of National Road Schemes – A Practical Guide* notes that climate change issues are largely outside the scope of an EIAR for individual road schemes as the issues and mitigation measures are the subject of specific policies and strategies set out by government. However, it is anticipated that the proposed road development will assist with the removal of traffic congestion from within Galway City and its environs by transferring existing and future traffic from the existing road network to the new road infrastructure. Therefore, journey times will reduce and journey time certainty will increase for both public transport and private vehicle users. The reduction in traffic congestion will facilitate the reallocation of available road space for cyclists, pedestrians and reconfigure the public transport network. This will result in reducing the number of short commuter journeys by car by facilitating journeys by bicycle/on foot. The positive impact of this modal shift is difficult to quantify in terms of carbon emissions, however, it will help to reduce emissions. Improvements to the Galway bus network have been identified as necessary to better cater for existing and future travel patterns in Galway City. The reallocation of road space for public transport will assist with the delivery of an improved bus network resulting in carbon emission reductions. In addition, the provision of improved public transport, traffic management measures, cycling and walking facilities and the introduction of the ‘Cross-city Link’ by the GTS will encourage a modal shift in line with Smarter Travel - A Sustainable Transport Future, A New Transport Policy for Ireland 2009 – 2020. This shift has the potential to reduce greenhouse gas emissions associated with the proposed road development in the future. CO_2 emissions for the average new car fleet were reduced to 120g/km by 2012 through EU legislation on improvements in vehicle motor technology and by an increased use of biofuels. The National Mitigation Plan outlines a number of existing mitigation measures and future possible mitigation measures under consideration relating to road transport, as follows: Existing: • Taxation system where a lesser road tax is paid where CO_2 emissions are within lower bands • Grants provided by Sustainable Energy Authority Ireland (SEAI) to incentivise the purchase of electric vehicles • Deploy natural gas refuelling stations and gas injection facilities • Using intelligent transport systems (ITS) to enhance the efficiency of infrastructure and fuel use in a transport network Under consideration: • Further measures to accelerate the take-up of low carbon technologies • Increase in carbon tax on transport fuel • The motor tax and VRT system could be further amended in line with improvements to energy efficiency and emissions reductions in cars and vans to additionally incentivise or maintain the advantages of purchasing of the lowest emitting vehicles • encourage the take-up of alternatively fuelled vehicles, removing or reducing supports or preferential treatment for petrol and diesel fuelled vehicles • Reduce maximum speed limits on motorways to 110km/hr in order to reduce emissions. It is noted that the design speed for the proposed road development at 100km/hr is less than the 120km/hr that usually applies to motorway schemes	It is expected that potential carbon emissions generated by the proposed road development can be offset by measures outlined in the Galway Transport Strategy, removing congestion in Galway City and measures outlined in the National Mitigation Plan.
Noise and Vibration		
Operational Road	The mitigation measures required to reduce traffic noise levels are specified based on the predicted noise levels for the Design Year of 2039 and noise mitigation is required for 102 properties along the proposed route of the proposed road development for the Design Year. Low Noise Road Surface (LNRS) will be used to reduce noise generated at source. Noise barriers as detailed in **Table 17.14** in **Chapter 17, Noise and Vibration** and **Figures 17.1.01** to **17.1.14** will be implemented to reduce noise levels along the propagation path between the source (proposed road development) and the specific receivers (houses, schools, churches etc.). These screens may be constructed as earth bunds, proprietary noise barriers or a combination of both.	No likely significant residual impact.
Human Beings		
Socio-economics	**Socio-economics** The provision of crossing facilities at the Foraí Maola Road, Troscaigh Road, Bearna to Moycullen Road L1321, Cappagh Road and Ballymoneen Road junctions to facilitate occasional pedestrian and/or cyclist crossings of the proposed road development. Pedestrian crossing facilities are also proposed at the terminus of the N59 Link Road North Junction at the N59	**Socio-economics** There will be significant positive residual impacts (and in some cases profound) due to improvements in

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
	Moycullen Road (Bushypark Junction) and at the slip road connections with the N84 Headford Road Junction. Cycle lanes are proposed to facilitate access to the Miller's Lane pitches and Gort na Bró and at the N84 Headford Road Junction. The following specific mitigation measures are proposed to improve journey amenity and minimise severance: • Provide pedestrian crossing facilities at junctions with minor roads serving local rural communities • Provide pedestrian crossing facility at Bushypark Junction with N59 Link Road North during construction and operation • Provide pedestrian crossing facilities at N84 Headford Road Junction during construction and operation • Provide a footpath within the proposed development boundary along School Road, Castlegar • Provide directional signage for a Briarhill Business Park, including a car dealership located here during both the construction and operational phases The proposed road development will facilitate the full implementation of all of the walking, cycling and public transport measures set out in the GTS. The transference of traffic from the existing N6 through Galway City to the proposed road development will provide an opportunity for improved pedestrian and cycle paths and crossing facilities, including continuity at major junctions and a modal shift to alternatives to the private car. Improved walking and cycling journey amenity is contingent on these appropriate facilities being provided. When implemented, such facilities will provide a significant improvement to pedestrian and cyclist journey amenity combined with reduced severance. Material Assets Non-Agriculture above outlines the proposed mitigation measures for the NUIG Sporting Campus facilities and Galway Racecourse.	journey times and connectivity between locations to the east and west of Galway City. Slight residual impacts on tourism during the construction phase will be replaced by a very significant net positive impact due to the improved connectivity provided by the proposed road development and by improved access into Galway City. The transfer of traffic from existing highly congested routes on the existing N6 and other roads, for example, in Doughiska, represents a significant to profound positive impact on journey times and journey amenity of drivers, cyclists and pedestrians as well as on the general amenity of people living and working alongside these roads. A profound positive residual impact will apply to businesses operating from the Parkmore Business Park and other nearby commercial/industrial estates in terms of much improved access to the N83 Tuam Road and between this road and the N6. This positive impact applies also to the business Boston Scientific, although a degree of severance will be introduced between existing and proposed facilities which will be mitigated by vehicle and pedestrian crossing facilities.
Irish Language Human health	**Irish Language** Place names shall be cited in accordance with the relevant Place Name Order issued under the Official Languages Act 2003 **Human health** Mitigation measures proposed for the potential air quality, noise, water and soils are specified above in the respective sections. The implementation of these mitigation measures, emissions, including air and noise will be adequately controlled to ensure no adverse effect on human health.	**Irish Language** There will be positive residual impact on the Irish Language once the proposed road development is operational. **Human Health** **Health Protection** From a community perspective, overall the implementation of the mitigation measures will result in a residual slightly positive impact. Similarly, from a psychological health point of view overall from community perspective the impacts of the proposed road development are assessed as being positive. Again, there are individuals who may be adversely affected and principal among these are likely to be those whose homes are to be compulsorily acquired. The residual impact will be positive. **Health Improvements** There is the potential for a very significant opportunity for health improvements associated with the proposed road development. These include the potential for economic development as well as tourism which in

Source/Scale of Effect	Control and Mitigation	Significant Residual Impacts
		itself is associated with an improvement in health status. There is the potential for improvements in social health with a reduction in unemployment and particularly long-term unemployment. Such a potential if realised will bring with it benefits including reduced inequality in society. There is also potential for increased opportunity to exercise. There is the potential for reduced traffic accidents with a corresponding reduction in mortality and morbidity. Ease of access and egress has the potential to improve social interaction. It also will allow quicker and more reliable access for emergency services such as ambulances. The residual impact will be positive. **Improvement of Access to Services** There is potential for significant improvement in access to services. The benefits of this apply to both the residents of Galway City and beyond. The residual impact will be very positive.

20.4 Compensatory Measures

20.4.1 Human Beings

Compensation for the acquisition of property is to be agreed as part of the land acquisition and is outside the scope of the EIA process and therefore, not discussed any further in this chapter.

20.4.2 Biodiversity

Where there are significant residual biodiversity impacts as a result of the proposed road development, despite the mitigation measures proposed, compensatory measures are proposed to offset or reduce the predicted impacts[3]. These are not compensatory measures in the context of the requirements of Article 6(4) of the Habitats Directive as they are not compensating for an impact that would adversely affect the integrity of any European site. As concluded in the NIS, the proposed road development will not adversely affect the integrity of any European site.

Habitat loss

The areas of residual alluvial forest [*91E0], Dry heath [4030], Calcareous grassland [6210] and *Molinia* meadow [6410] that will be lost outside of any European site as a result of the proposed road development will be compensated for. In each case the area of each habitat type being provided is greater than that being lost.

The losses of Limestone pavement habitat (outside any European site), a Petrifying spring (outside any European site) and Wet heath habitat [4010] (outside any European site), associated with the proposed road development cannot be directly compensated. However, areas of related habitats will be created to provide a biodiversity gain for both peatland and limestone associated habitats locally. The area of Dry heath habitat being created is c.7.06ha which is greater than the combined losses associated with this habitat type and any Wet heath/*Molinia* meadow mosaics (c.4.78ha). The area of Calcareous grassland habitat being created is c.7.14ha which is greater than the combined losses of Limestone pavement and Calcareous grassland habitat combined (c.1.24ha).

The full details of the Habitat Compensation Management Plan for each of the Annex I habitat types being compensated for, including monitoring, are presented in **Appendix A.8.26**. The areas where compensatory habitats will be created are shown on **Figures 8.23.1** to **8.23.14**.

In compensating for the losses of these habitat types, the proposed road development is not likely to result in a significant residual effect, at any geographic scale, on Residual alluvial forest [*91E0], Dry heath [4030], Calcareous grassland [6210] or Molinia meadow [6410] post compensation measures.

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[3] “Compensation describes measures taken to make up for residual effects resulting in the loss of, or permanent damage to ecological features despite mitigation” (CIEEM, 2016)

This is summarised below in **Table 20.3**.

There are a number of habitat types of a local biodiversity importance that will be permanently lost as a result of the proposed road development, and where significant residual negative effects are likely:

- Calcareous springs (FP1)
- Dry-humid acid grassland (GS3)
- Poor fen and flush (PF2)
- (Mixed) broadleaved woodland (WD1)
- Hedgerows (WL1)
- Treelines (WL2)

Of these, the planting proposed in the landscape design will compensate for the loss of the areas of (mixed) broadleaved woodland (WD1), hedgerows (WL1) and treelines (WL2) by providing the equivalent, or greater, area to that being permanently lost to the proposed road development, as follows:

- (Mixed) broadleaved woodland (WD1) - > 2.62ha
- Hedgerows (WL1) - > 7.8km
- Treelines (WL2) - > 4km

In compensating for the losses of these habitat types, the proposed road development is not likely to result in a significant residual effect, at any geographic scale, on (mixed) broadleaved woodland (WD1), hedgerows (WL1) and treelines (WL2).

However, the proposed road development is likely to have a significant residual negative effect, at the local geographic scale, as a result of the permanent loss of fifteen calcareous spring features (FP1), c.7.81ha of Dry-humid acid grassland (GS3) and c.0.13ha of poor fen and flush habitat (PF2).

Table 20.3: Summary of Residual Priority Annex I/Annex I habitat loss outside any European site after compensation

Annex I habitat type	Permanent Area of Habitat Loss	Area of Compensatory Habitat Created	Residual Habitat Loss	Residual Impact Significance Post-compensation
Petrifying springs [*7220]	One Petrifying spring feature	n/a	One Petrifying spring feature	Likely significant residual effect at the county geographic scale
Residual alluvial forest [*91E0]	c.0.1ha	c.0.18ha	None	No likely significant residual effect
Limestone pavement [*8240]	c.0.54ha	n/a	c.0.54ha	Likely significant residual effect at the international geographic scale
Wet heath [4010]	c.2.06ha	n/a	c.2.06ha	Likely significant residual effect at the national geographic scale
Dry heath [4030]	c.1.85ha	c.7.06ha	None	No likely significant residual effect
Wet heath/Dry heath/*Molinia* [4010/4030/6410]	c.0.87ha	n/a	c.0.87ha[4]	Likely significant residual effect at the national geographic scale
Calcareous grassland [6210]	c.0.7ha	c.7.14ha	None	No likely significant residual effect
Molinia meadow [6410]	c.0.28ha	c.0.49ha	None	No likely significant residual effect

Bats

Loss of the more "significant" roosts (e.g. maternity roosts or roosts used by Lesser horseshoe bats) will be compensated by the erection of replacement structures (artificial roosts) in locations close to the original roost.

[4] Assumed to be Wet heath, the loss of which cannot be directly compensated for.

There is a dual purpose to the artificial roosts. Firstly, to ensure that there is no net loss of roosting opportunities for the bats confirmed to be roosting within the proposed development boundary. Secondly, it has been recognised that there will be an inevitable increase in mortality rates due to road collisions as suggested by scientific evidence (see **Section 8.5.6.2.2**). So the second function of the replacement roosts is to create improved conditions for bats to breed and to offset the likely increase in mortality.

Four artificial roost structures are proposed at the following locations:

- Aughnacurra
- Menlo Castle
- Menlo Woods
- Ballindooley

The detailed fit-out of these artificial roosts will follow the recommendations of an experienced bat ecologist and further consultation with the Vincent Wildlife Trust will take place to ensure that their experiences in these techniques are taken into account and are detailed in **Chapter 8, Biodiversity**.

Artificial roost structures will be screened from the effects of construction phase disturbance by means of solid hoarding or brushwood screens with an appropriate buffer zone around the roost. The dimensions of the planting will depend on the local topography and surrounding landscape and will be decided on a case-by-case basis by the bat ecologist.

It should be noted that the mitigation strategy, outlined above in **Section 20.2**, has included ensuring that passage underneath the proposed road development in the vicinity of the roosts has been facilitated by including culverts underneath the proposed road development in locations as close to the roosts as possible.

<u>Retrofitting of Existing Structures</u>

At Ch. 12+960 the detached converted garage (next to PBR183) to the south of the proposed road development to be retained and converted for use by several species including Brown long-eared bats and Lesser horseshoe bats. This building is in a strategically-important location as it will connect to the linear planting on the south side of the proposed road development and is just c.250m from the proposed Castlegar Wildlife Overpass in and within a local ecological corridor leading to Cooper’s Cave, a proven hibernation and mating site for Lesser horseshoe bats. This structure will undergo minor interior and exterior modifications to create warm areas in the roof space for summer roosting and breeding and also cold conditions for hibernation. **Plate 8.9** in **Chapter 8, Biodiversity** shows this location.

<u>Bat Boxes</u>

Bat boxes will preferably be located near the roosts to be lost but not immediately adjacent to the proposed road development where risk of collision with vehicles is highest.

Bat boxes will be erected by, or under the supervision of, a bat specialist.

These bat boxes will target Common and Soprano pipistrelle bats and Brown long-eared bats and will consist of Schwegler Type 1FF and 2FN bat boxes (or equivalent) as these have been demonstrated as being successful for these species in Ireland[5]. Mounting boxes on poles close to the edge of tree canopies will also allow the long-term retention of the boxes, as opposed to mounting boxes on small trees which have limited longevity.

A rocket box (as shown in **Appendix A.8.25** - see Drawing GCOB-3000-D-002 in Annex F of the bat derogation licence application) will be installed at Ch. 3+320 near the roost at PBR241 (ref **Figure 8.21.1**) rather than a bat box fixed to the building itself so as not to detract from its cultural heritage value.

Box locations, as shown on **Figure 8.24.1** to **8.24.15**, will include the following:

- Ch. 3+320: Rocket box to be erected to west of the building PBR241
- Ch. 10+050: 5 boxes to be erected along the edge of the tree canopy near the underpass
- Ch. 11+400: 4 boxes to be erected on the entrance road into Lackagh Quarry
- Ch. 15+100: 4 bat boxes to be erected south of Galway Racecourse

In the case of bat boxes provided as replacements for bat tree roosts to be felled, boxes will be Schwegler Type 1F bat boxes (or equivalent) erected on suitable trees or structures retained within the proposed development boundary in the vicinity of the tree to be lost where possible. The type and siting of any bat boxes required will be determined by the bat specialist at that time but preliminary areas for bat boxes have been identified in the areas of woodland around Menlough, Coolagh, on retained structures and the quarry walls at Lackagh Quarry and in areas near attenuation and infiltration ponds.

All new roosts, retrofitted structures and bat boxes will be erected in advance of the commencement of site clearance so that replacement roosts are available to bats and that there is reasonable chance that they will have discovered them prior to loss of the existing roost. Boxes can be erected at any time of year and preferably as soon as the necessary consents are in place for the proposed road development.

<u>Protection of proposed artificial roosts during construction works</u>

- Newly created roosts and bat boxes within the proposed development boundary will be protected from the adverse effects of noise and lighting during the construction phase as it is an essential element of the mitigation strategy that they are accessible and usable by bats during this time
- All existing and proposed artificial roosts retained within the proposed development boundary will be surrounded with wooden panels to a height that allows shading and shelter of key roost access features
- Planting around the existing and proposed artificial roosts retained within the proposed road development will include fast growing shrub species, or fast-

[5] McAney K. and Hanniffy, R. (2015) *The Vincent Wildlife Trust's Irish Bat Box Schemes* http://www.mammals-in-ireland.ie/wp-content/uploads/2015/11/Ireland-Bat-Box-Project-Report-WEB.pdf

growing willow if the ground conditions permit. Planting will aim to guide bats away from the open construction zone toward linear features. Use of non-native species may be appropriate in some locations where it is important to get vegetation established

- All structures will be locked and not used for other purposes such as storage of materials or shelter without agreement from the Ecological Clerk of Works
- The maintenance of the existing and proposed artificial roosts retained within the proposed development boundary, in a state that they are accessible and usable by bats, will be carried out by the Contractor until the completion of the proposed road development whereby it will be taken in charge by the local authority. Maintenance will include standard building repairs over time and responding to the results of the roost monitoring (e.g. increasing or reducing humidity)

<u>Compensation for loss of foraging habitat</u>

Approximately 7ha of woodland-pasture-hedgerow-scrub habitat will be removed from the area between the River Corrib and An Bóthar Nua in Menlough. This habitat is used by the Lesser horseshoe bat population and therefore there is a risk that there may be reduced breeding success if replacement planting is not made available.

An area of land has been identified which is within the known core foraging area of the Menlo Castle roost (PBR06) but is not optimal feeding habitat. It is composed of open fields of varying size used for low density cattle grazing. Hedgerows in this area will be augmented and thickets of hazel, hawthorn, holly and oak will be provided in several of the fields to create pockets of wood and grassland habitat. Grazing will continue on the lands as it has been shown that foraging over grazed land is preferred to ungrazed lands (Downes et al, 2016).

Connectivity to foraging areas will also be secured through tying the proposed planting strips to hedgerows and woodland edges.

Planting of new hedgerows in fields between the proposed road development and Menlo Castle will improve the foraging resources of this core foraging area. Such planting will include additional native hedgerows planted across the existing fields to increase the lengths of hedgerows close to the proposed new roost for Lesser horseshoe bats (refer to **Section 8.6.7.2**). The fields will still be grazed and the hedgerows can be fitted with field gates as required providing gaps are kept to a minimum.

The area of habitat enhancement for the purposes of offsetting the loss of suitable bat habitat due to the proposed road development amounts to approximately 8ha. (refer to **Figure 8.24.7**).

The monitoring programme for bats outlined in **Tables 20.1** and **20.2** above also relates to the compensation measures for bats described in this section.

Summary

The proposed road development, despite the implementation of the mitigation and compensation measures proposed, will have the following likely significant residual effects on biodiversity:

- A likely significant residual effect, at the international geographic scale, for the permanent loss of c.0.54ha of the priority Annex I habitat Limestone pavement [*8240]
- A likely significant residual effect, at the national geographic scale, for the permanent loss of c.2.93ha of the Annex I habitat Wet heath [4010][6]
- A likely significant residual effect, at the county geographic scale, for the permanent loss of a Petrifying spring [*7220] feature at Lackagh Quarry
- A likely significant residual effect, at the county geographic scale, for the potential permanent loss of a Peregrine falcon nest site at Lackagh Quarry
- A likely significant residual effect, at the local geographic scale, on all bat species due to the presence of the proposed road development within their foraging areas
- A likely significant residual effect, at the local geographic scale, for the permanent loss of 15 calcareous springs (FP1) at Lackagh Quarry, c.7.81ha of Dry-humid acid grassland (GS3) and c.0.13ha of Poor fen and flush habitat (PF2)

These significant residual impacts will also affect the following local biodiversity areas:

- Coast Road (R336) to the N59 Moycullen Road local biodiversity area

  Residual impact at the national geographic scale for the loss of Wet heath [4010] habitat

  Residual impact at the local geographic scale for the loss of Dry-humid acid grassland (GS3) and Poor fen and flush habitat (PF2) along with impacts on bat species present here

- River Corrib and the Coolagh Lakes local biodiversity area

  Residual impact at the local geographic scale due to impacts on bat species present here

- Menlough to Coolough Hill local biodiversity area

  Residual impact at the international geographic scale for the loss of Limestone pavement [*8240] habitat

  Residual impact at the county geographic scale for the loss of Petrifying springs [*7220] and impact on the Peregrine falcon

[6] As noted in **Table 8.40**, this is comprised c.2.09ha of Wet heath dominated habitat and an additional c.0.82ha of habitat mosaic which contains Wet heath.

Residual impact at the local geographic scale from the loss of Calcareous springs (FP1) and along with impacts on bat species present here

- Ballindooley – Castlegar local biodiversity area

  Residual impact at the local geographic scale due to impacts on bat species present here

- Doughiska local biodiversity area

  Residual impact at the international geographic scale for the loss of Limestone pavement [*8240] habitat

  Residual impact at the local geographic scale due to impacts on bat species present here

Although the significant residual effects associated with the losses of Limestone pavement and Wet heath habitat cannot be directly compensated for, areas of related habitats will be created to provide an overall biodiversity gain for both peatland and limestone associated habitats locally. The area of Dry heath habitat being provided is c.7.06ha which is greater than the combined losses of all peatland habitats combined (c.4.78ha). The area of Calcareous grassland habitat being provided is c.7.14ha which is greater than the combined losses of Limestone pavement and Calcareous grassland habitat combined (c.1.24ha).

20.5 Overview

Galway City and its environs have critical transport issues that require urgent resolution. There are however significant constraints for developing new transport infrastructure for Galway given (i) the physical form of the city, (ii) the limited space available, (iii) the built environment and residential areas on both sides of the River Corrib, and (iv) the presence of designated ecological sites.

Given these constraints the proposed road development will result in significant residual impacts as outlined above in this chapter. However, this must be viewed and balanced in the context of the overall benefit that the proposed road development will deliver, described above and in **Chapter 3, Need for the Proposed Road Development**.

Numerous alternatives have been considered which are more damaging in terms of property demolitions and other potential environmental impacts in comparison to the proposed road development. However, there are very significant/significant residual impacts remaining including but not limited to the demolition of 44 residential properties and the further acquisition of 10 residential properties, demolition of four commercial properties and the further acquisition of one commercial property and acquisition of one residential planning permission and a significant residual impact to NUIG Sporting Campus.

The proposed road development is a key element of the Galway Transport Strategy and represents the best solution to the transport issues described in **Chapter 3, Need for the Proposed Road Development** and supports more sustainable travel for the following reasons:

- It will provide a **strategic route** across the River Corrib without the need to go through the city
- This strategic route will be of a **high standard** cross-section and will provide the **capacity required for the strategic traffic** serving the city and connecting the county to the national network
- Improves **connectivity to the Western Region** i.e. the county areas and hinterland beyond the city zone
- Moreover, access to this strategic route is limited to the junctions which will **protect the road asset in the future** and means that its **capacity is secure**
- This route is of European importance given that the **TEN-T comprehensive network designation** extends west of the city to the terminus of proposed road development and will provide a link to the Western Region of the standard of a comprehensive route in accordance with TEN-T
- This route provides connections to **essential city links** to better distribute traffic
- By **tackling the city's congestion issues**, it will provide a **better quality of life** for the city's inhabitants and provide a much **safer environment** in which to live
- By **reducing the number of cars** on the roads within the city centre and improving streetscapes, workers and students are facilitated to commute using **multi-modal transport means**. This includes travelling on foot, by bicycle and on the public transport system
- Provides connectivity to the national roads via junctions to maximise the transfer of cross-city movements to the new road infrastructure, thus **releasing and freeing the existing city centre zone from congestion** caused by traffic trying to access a city centre bridge to cross the River Corrib
- Attracts traffic from the city centre zone thus facilitating reallocation of road space to public transport leading to **improved journey time reliability for public transport**
- **Caters for the strong demand** between zones on either side of the city
- Provides additional river crossing with **connectivity back to the city** either side of the bridge crossing
- Facilitates **improved city centre environment** for all due to reduced congestion, thus **encouraging walking and cycling** as safe transport modes

The N6 Galway City Ring Road is the optimum transport solution and is consistent with proper planning and sustainable development and this view is supported /validated by the inclusion of policy support for both GTS and constituent measures, including the N6 Galway City Ring Road, in the relevant Galway Development Plans.

21 Schedule of Environmental Commitments

This chapter of the EIAR collates all of the design and mitigation measures (referred to in this chapter as Environmental Commitments) to be implemented during the construction of the proposed N6 Galway City Ring Road, here after referred to as the proposed road development, to reduce/avoid as far as practical significant impacts on the receiving environment.

The following environmental commitments are an integral element of the application for Approval. Further work will develop the design of the proposed road development in a manner such that there is no material change in terms of significant adverse effects on the environment. Opportunities may be identified to further reduce the significance of adverse impact and, in some cases, improve the residual impact. In this way the design measures, mitigation strategies, objectives and implementation measures set out below may be refined so to provide the optimum solution based on available construction techniques and technologies at the time of construction.

Best practice and good construction practice when referred to in this document refer to measures contained in modern guidance documents which set out the practice and procedures for environmental protection during construction and operational phases of a road project.

Where Legislation, Standards or Guidance Documents are referred to it should be noted that at the time of construction or operation of the proposed road development any amendments to these documents are applicable.

This section provides a summary of the main commitments under each of the environmental headings listed. Full details of the various commitments should be obtained by reference to the individual chapters of the EIAR as a whole.

In the following tables "C" denotes a commitment which refers mainly to the construction phase and "O" denotes a commitment which refers mainly to the operational phase of the proposed road development.

21.1 General

Ref No.	Stage	Commitments
1.1	C	Contract documents will include a requirement for the Contractor to update and finalise the Construction Environmental Management Plan (CEMP) (**Appendix A.7.5**) for the proposed road development prior to construction once appointed and to implement and maintain it during the construction phase.
1.2	C	The final Schedule of Environmental Commitments will be included in the CEMP. The CEMP will detail implementation methodologies for all environmental commitments.
1.3	C	There will be a contract management team appointed by the client on site for the duration of the construction phase. The team will supervise the construction of the works including monitoring the Contractor's performance to ensure that the proposed construction phase environmental commitments are implemented and that construction impacts and nuisance are minimised.
1.4	C	The construction management team will liaise with neighbours and the general community during the construction phase to ensure that any disturbance is kept to a minimum.
1.5	C	The Contractor's team will include a Senior Environmental Manager (SEM) who will be responsible for implementation of the Construction Environmental Management Plan (CEMP) during construction. The SEM will draw up a schedule of monitoring required, listing the type of report expected and detailing to who the reports should be sent, etc. It is the responsibility of the SEM to ensure that all monitoring is carried out by competent persons. Where the monitoring results fall outside the range contractually required, the SEM is responsible for initiating and reporting on corrective action. This may require the alteration of relevant Environmental Control Measures. The SEM will provide a briefing for all of the Contractor's senior management including the Project Manager, Programme Manager, Construction Manager, Design Engineers, Structures Agents and Site Agents on the CEMP and the Environmental Commitments/Requirements that must be met during the construction phase. The Employer's Site Monitoring Team will be monitoring compliance with the CEMP.
1.6	C	Pollution control measures will be installed upstream of each outfall from the proposed road development. These measures will include an appropriate combination of filter drains, attenuation ponds, swales, petrol and oil interceptors, wetlands and infiltration trenches/ponds (ref **Chapter 5, Description of the Proposed Road Development**).
1.7	C	When the proposed road development is in cutting or on embankment less than 1.5m high, combined filter drains will be provided. Where the proposed road development is on embankment between 1.5m and 6.0m, carriageway runoff will be picked up in surface water channels alongside the carriageway.
1.8	C	Where filter drains and swales cannot be used, alternative forms of vegetated pollution control will be employed prior to outfalling to surface waters such as treatment wetlands.
1.9	C	Treatment wetlands will have a permanent pool of minimum depth and a volume to cater for the first flush rainfall event.
1.10	C	In areas of extreme or high vulnerability groundwater areas or karstified areas, sealed drainage systems will be used.

Ref No.	Stage	Commitments
1.11	C	Flow restriction and attenuation storage measures will be provided at each surface water outfall from the mainline and link roads of the proposed road development.
1.12	C	Attenuation ponds will cater for storm events up to the 1 in 100-year storm period event. An overflow discharge facility will be provided for storm events in excess of 1 in 100-year return periods.
1.13	C	Petrol/Oil Interceptors will be employed at every outfall from the mainline and link roads of the proposed road development.
1.14	C	A minimum emergency spillage containment volume of 25m^3 will be provided at all outfall locations from the mainline of the proposed road development as per DN-DNG-03022.
1.15	C	Side roads (regional, local and minor access roads) with kerbs will be drained using gullies with carrier drains or combined filter/carrier drains. Piped drains will discharge to an outfall, a sealed drain, sufficiently sized existing drainage systems, a ditch, a swale or to the mainline drainage system. Where topography and surface watercourse conditions dictate, a soakaway or infiltration trench/basin may be required.
1.16	C	Side roads that do not require kerbs will be drained using either over-the-edge drainage or combined filter drains. The surface water will discharge to a sufficiently sized existing drainage system, an outfall, a sealed drain, a ditch, a swale or to the mainline drainage system.
1.17	C	Access will be provided to all elements of the drainage system including the spillage containment facilities, the pollution control and the attenuation ponds.
1.18	C	Throughout the course of the construction of the proposed road development, on-going visual inspections and monitoring of the haul routes along public roads will be undertaken to ensure any damage caused by construction traffic is recorded and that the relevant local authority is notified. Arrangements will be made to repair any such damage to an appropriate standard in a timely manner such that any disruption is minimised. Upon completion of the construction of the proposed road development, the surveys carried out at pre-construction phase shall be repeated and a comparison of the pre and post construction surveys carried out to determine any sites requiring remediation work post construction.
1.19	C	All project staff and material suppliers will be required to adhere to the Construction Traffic Management Plan (CTMP). As outlined within the CTMP, the Contractor shall agree and implement monitoring measures to confirm the effectiveness of the CTMP and compliance will be monitored by the resident engineer on behalf of the client. Regular inspections/spot checks will also be carried out to ensure that all project staff and material supplies follow the agreed measures adopted in the CTMP.
1.20	C	Any structural damage caused to buildings/structures/wells as a result of the construction will undergo a full stabilisation and rehabilitation works.
1.21	C	The following are the measures that will be taken to ensure that the construction site and surroundings are maintained to a high standard of cleanliness: Daily inspections will be undertaken to monitor tidiness. A regular program of site tidying will be established to ensure a safe and orderly site. If necessary, scaffolding will have debris netting attached to prevent materials and equipment being scattered by the wind.

Ref No.	Stage	Commitments
		Food waste will be strictly controlled on all parts of the site. Wheel wash facilities will be provided for vehicles exiting the construction site. Wheel wash run off will be stored in an onsite storage tank and will be disposed of by permitted waste haulage company at a permitted or licensed facility. In the unlikely event that mud is carried from the construction site to the public road, it will be cleaned as required and will not be allowed to accumulate. Loaded lorries and skips will be covered if required. Surrounding roads used by trucks for access to and egress from the site will be inspected regularly and cleaned, using an approved mechanical road sweeper, when required. In the event of any fugitive solid waste escaping the site, it will be collected immediately and removed to storage on site, and subsequently disposed of in the normal manner.

21.2 Waste

Ref No.	Stage	Commitments
7.1	C	Waste generated during the construction phase will be carefully managed according to the accepted waste hierarchy which gives precedence to prevention, minimisation, reuse and recycling over disposal with energy recovery and finally disposal to landfill.
7.2	C	The waste hierarchy will be implemented by identifying opportunities to firstly prevent waste from being produced, and secondly minimise the amount of waste produced.
7.3	C	Where prevention and minimisation will not be feasible, ways to reuse or recycle waste will be sought, preferably on-site to avoid the impacts arising from transportation. If this is not feasible, opportunities to reuse or recycle the waste off-site will be investigated or waste will be sent to an energy recovery facility, and only where there is no alternative, will waste be disposed of to landfill.
7.4	C	All waste removed from the site will be collected only by Contractors with valid waste collection permits, under the Waste Management (Facility Permit and Registration) Regulations 2007 and (Amendment) Regulations 2008, 2014, 2015. All facilities to which waste will be taken will have appropriate waste licences or permits, under the Waste Management Acts 1996 - 2011, and the regulations thereunder, allowing them to accept the type of waste that is to be sent there.
7.5	C	Hazardous waste generation will be minimised, and such waste will be recovered where feasible, and only disposed of if recovery is not feasible. Hazardous waste will be managed in accordance with the relevant legislation.
7.6	C	All wastes from the construction of the proposed road development will be delivered to authorised waste facilities in accordance with the Waste Management Acts 1996-2011. By only using facilities with the appropriate waste permits/licence, Galway County Council will be satisfied that the Contractor will comply with the objectives of the Waste Management Act and that any environmental emissions (noise, dust, water) are managed at the destination site and therefore are legally the responsibility of the

Ref No.	Stage	Commitments
		owner/operator of the destination site. In this manner Galway County Council can be satisfied that the off-site spoil management aspect of the development is legally compliant with environmental and waste management legislation.
7.7	C	In general, construction waste materials may include general construction debris, scrap timber and steel, machinery oils and chemical cleaning solutions. The practice of excessive purchase of materials and equipment to allow for anticipated wastage will be avoided.
		The Construction and Demolition Waste Co-Ordinator will arrange for a waste audit of the proposed road development once construction has fully commenced on site and of any facilities to which waste from the proposed road development is delivered as required. The Employer will receive summaries of any audit reports which will be completed within three months of the end of each calendar year. The effectiveness and accuracy of the documentation will be monitored on a regular basis via routine site visits.
7.8	O	Operational waste will be delivered to authorised waste facilities in accordance with the Waste Management Acts 1996 to 2016.
		Following construction, the Non-native Invasive Species Management Plan will be updated for the operational phase, taking into account the results of the detailed construction non-native invasive species management plan and operational maintenance requirements. Follow on treatment methods such as chemical treatment may be employed if specified in the requirements for ongoing control.

21.3 Human Beings, Population and Health

Ref No.	Stage	Commitments
18.1	C/O	Provide pedestrian crossing facilities at junctions with minor roads serving local rural communities.
18.2	C	Provide temporary visual screening from construction works at St. James' Church cemetery in Bushypark and at St. James' School, Bushypark.
18.3	C/O	Provide pedestrian crossing facility at Bushypark Junction with N59 Link Road North during construction and operation
18.4	C	Avoid any prolonged severance and minimise duration of use by construction traffic of An Seanbóthar.
18.5	C	Provide for alternative access along the bank of the River Corrib, along with prior advice for walkers, if access restrictions apply due to construction of the overhead bridge crossing.
18.6	C	Phase construction works to minimise impacts on racing events at Galway Racecourse.
18.7	C	Provide directional signage for access to car dealership and An Post sorting centre on N83 during construction.
18.8	C/O	Provide pedestrian crossing facilities at N84 Headford Road Junction during construction and operation.
18.9	C/O	Provide a footpath within the proposed development boundary along School Road, Castlegar.

Ref No.	Stage	Commitments
18.10	C	Provide directional signage for a Briarhill Business Park, including a car dealership located here during both the construction.
18.11	C/O	Take measures to ensure that cul-de-sacs or adjacent lands are not used for illegal parking in the operational phase.
18.12	C	During construction, all public notifications and all public project updates are provided in both Irish and English languages.
18.13	C	While it is expected that day-to-day communications involved in the construction of the proposed road development will be through the English language, the Contractor shall have the capacity to communicate and correspond through the use of the Irish language and to devote adequate and proportionate staff resources to dealing with any individual wishing to correspond and communicate through the Irish language.
18.14	O	Placenames shall be cited in accordance with the relevant Placename Order issued under the Official Languages Act 2003.

21.4 Material Assets Non-Agriculture

Ref No.	Stage	Commitments
15.1	C	In the event of an approval of the Protected Road Scheme and Motorway Scheme and approval under Section 51 of the Roads Act 1993 (as amended), by An Bord Pleanála and subject to the availability of funding, Notice to Treat will be served firstly on owners, lessees and occupiers of the dwelling houses and commercial properties to be acquired, within six months of the scheme becoming operative, unless an application has been made for Judicial Review, in which case the Notice to Treat will be served in accordance with the provisions of Section 217 (6A) of the Planning and Development Act 2000 as inserted by the Compulsory Purchase Orders (Extension of Time Limits) Act 2010. Compensation will be agreed or determined by the property arbitrator as soon as possible after service of Notice to Treat. After compensation has been agreed or determined and satisfactory title has been produced, part payment can be made while the claimant remains for an agreed period in the property to be acquired. This will facilitate the claimant in removing uncertainty and will facilitate arrangements being made, as early as possible, to secure a replacement property.
15.2	C	Where existing access to property is affected, this will be reinstated or an alternative access provided.
15.3	C	Where the infrastructure for service providers is impacted, this will be diverted or reinstated in accordance with service providers' requirements prior to construction.
15.4	C	During construction, restricted access across the construction area at the NUIG Sporting Campus facilities will be maintained.

Ref No.	Stage	Commitments
15.5	C	Alternative pitch facilities will be provided to replace the existing pitches directly impacted by the proposed road development. The facilities include a floodlit 3G GAA pitch and a floodlit 3G training area and associated site infrastructure for the drainage of these pitches and furniture such as ball-stop netting. The proposed road development also intercepts the existing sports pavilion resulting in direct impacts to its western end and the building will be modified as follows: • The existing western plant room, 1 no. changing room, 1 no. storage area, 1 no. weights area and associated access hallways on both ground floor and upper levels will be demolished. • The western plant room and its associated plant will be relocated. • Construction and reconfiguration of the internal and external walls, roof, windows and door locations.
15.6	C	During the construction of the River Corrib Bridge, alternative access to that along the bank of the River Corrib will be provided.
15.7	C	Temporary stables will be provided for Galway Racecourse during the construction of the proposed road development until such time as the Galway Racecourse Tunnel is complete and the permanent stables and associated facilities are constructed.
15.8	C	Mitigation measures as detailed in individual accommodation works agreements, such as boundary treatment, domestic entrances, property condition surveys (as outlined below for Noise and Vibration), provision of ducting to facilitate services, maintenance of access during construction amongst other items will remove impacts related to the properties with partial landtake.
15.9	C	Where the infrastructure for service providers is impacted, this will be diverted or reinstated in accordance with service providers' requirements prior to construction. Service users will be notified in advance of any temporary disruption or outages necessitated by the construction works. The disruption to services or outages will be carefully planned so the duration is minimised.
15.10	C	Public water supply and foul water systems affected will be reconnected. All necessary diversions will be carried out in accordance with the local authority and Irish Water's requirements. Where private potable water supplies are impacted, a new well or alternative water supply or financial compensation for the loss of the well will be provided.

21.5 Material Assets – Agriculture

Ref No.	Stage	Commitments
14.1	C	The landowner will be provided with access to all separated land parcels during the construction of the proposed road development. Where temporary disruptions to this access occur landowners will be notified in advance.
14.2	C	Where existing water and electricity supplies are disrupted during the construction phase an alternative water source or electricity supply will be made available e.g. water tanker or electric cable ducting. If access to surface drinking water sources are permanently restricted alternative groundwater supplies will be provided (or compensation to allow farmer drill his own well).
14.3	C	Suitable boundary fencing will be erected to delineate the line of the proposed development boundary and prevent disturbance to adjacent land.
14.4	C	A key contact person will be appointed during the construction phase to facilitate communications between affected landowners and to facilitate the re-organisation of farm enterprises by farmers during critical times.
14.5	C	Landowners with lands adjoining sites where either rock breaking, blasting or piling takes place will be notified in advance of these activities.
14.6	C	The impacts on water quality will be minimised by way of a programme of environmental commitments for surface and ground water sources as described in Hydrogeology and Hydrology sections.
14.7	C	The spread of dust onto adjoining lands will be minimised by way of environmental commitments set out in the air section. Typically, the impact of dust on agricultural grazing livestock is not significant.
14.8	C	Where drainage outfalls are temporarily altered or land drains blocked or damaged an adequate drainage outfall will be maintained and land drains will be repaired.
14.9	O	All separated land parcels will be accessible either via the local road network, via accommodation access roads and access tracks.
14.10	O	Where existing water and electricity supplies to fields or farm yards are severed, the supply will be reinstated by provision of ducting where possible. Alternatively, where ducting is not feasible a permanent alternative water source or electricity supply will be made available. Compensation payments will enable farmers to replace power and water supplies.
14.11	O	Water from the proposed road development will be diverted to attenuation ponds before discharging to watercourses or to ground. The drainage design of the proposed road development will intersect existing field drains and carry the drainage water to suitable outfalls.
14.12	O	Landscaping along the proposed road development will minimise the visual impact on farms along the route of the proposed road development and will over time improve shelter in affected farms.

21.6 Air Quality and Climate

Ref No.	Stage	Commitments
16.1	C	The assessment of potential construction impacts contained in **Section 16.5.3** of **Chapter 16, Air Quality and Climate** includes the implementation of ‘standard mitigation’, as stated in the TII Guidelines. This shall include the following measures: • Spraying of exposed earthwork activities and site haul roads during dry weather. • Provision of wheel washes at exit points. • Control of vehicle speeds and speed restrictions. It is proposed that site traffic is restricted to 20km/hr. This will help to minimise the occurrence of dust re-suspension. • Sweeping of hard surface roads.
16.2	C	The following measures will be implemented. These measures are based on best practice as outlined in the British Research Establishment (BRE) document ‘Controlling particles, vapour and noise pollution from construction sites’ and the Institute of Air Quality Management (IAQM) ‘Guidance on the assessment of dust from demolition and construction’, 2016. • A public communication strategy will be implemented by the Contractor which will outline procedures to inform members of the community on activities that may be disruptive, further details are contained in the CEMP in **Appendix A.7.5**. This appendix also includes details of a complaints register which will be implemented during the construction phase. • Exhaust emissions from vehicles operating within the site, including trucks, excavators, diesel generators or other plant equipment, will be controlled by the Contractor through regular servicing of machinery. • During dry periods when dust generation is likely or during windy periods, construction areas and vehicles delivering material with dust forming potential will also be sprayed with water, as appropriate. • Areas where materials will be handled and stockpiled will be positioned away from main site access roads. These areas will also be designed to minimise their exposure to wind – all stockpiles shall be kept to the minimum practicable height with gentle slopes. • There shall be no long-term stockpiling on site and storage time will be minimised. • Material drop heights from plant to plant or from plant to stockpile will be minimised. • Water suppression will be used during the demolition of buildings. • Crushing and concrete batching plant will be located as far from sensitive receptors as is reasonably practicable. All storage bins and transfer points will be covered. Silos will be fitted with reverse jet air filters.
16.3	C	Dust screens will be implemented at locations where there is the potential for air quality impacts during the construction phase at locations where sensitive receptors are located within 100m of the works. In addition, a 2m dust screen will be provided at the locations in the areas of the overlap of the proposed road development and the Lough Corrib cSAC and where the proposed road development is adjacent to Moycullen Bogs NHA.
16.4	C	Staff training and the vigilant management of operations ensure that all dust suppression methods are implemented and continuously inspected.

Ref No.	Stage	Commitments
		Further details on employee training are provided in the CEMP in **Appendix A.7.5**.
16.5	C	Dust deposition and PM_{10}/$PM_{2.5}$ will be carried out to confirm the effectiveness of the environmental commitments.
16.6	C	Dust deposition monitoring will be conducted at a number of locations in the vicinity of the proposed road development. At a minimum, monitoring will be carried out at the two nearest sensitive receptors at locations where works of a 'major' scale is proposed while works are taking place in proximity. Monitoring will be carried out using the Bergerhoff method, i.e. analysis of dust collecting jars left on-site (German Standard VDI 2119, 1972). Results will be compared to the TA Luft guidelines. Should an exceedance of the TA Luft limit occur during the construction phase or a complaint be received in relation to dust levels, additional environmental commitments, for example more regular spraying of water, will be implemented. At least one month of dust deposition monitoring will be carried out in advance of the commencement of works to determine a baseline.
16.7	C	It is proposed to carry out particulate monitoring (PM_{10} and $PM_{2.5}$) at the nearest sensitive receptors upwind and downwind of the construction works where sensitive receptors have been identified within 25m of the works. This monitoring programme will take place when works likely to generate dust are being carried out. The monitoring will allow direct comparison with the PM_{10} and $PM_{2.5}$ air quality standards on a daily basis.
16.8	C	The particulate and dust deposition limits will be used to determine potential occurrences of dust nuisance associated with the proposed construction works. Should the particulate and dust deposition limit values be approaching an exceedance during the construction works, the levels will be recorded by the Contractor. An investigation will subsequently be carried out to determine potential causes and the options available to reduce the level of dust.
16.9	C	All potential causes for the high dust levels will be analysed. These will include the construction works taking place, potential off site sources and meteorological conditions. Should the construction works taking place be identified as the primary cause of the high level, the Contractor will ensure that the environmental commitments listed above are improved upon. Should high dust levels continue to occur following these improvements, the Contractor will provide alternative environmental commitments and/or will modify the construction works taking place.
16.10	C	The following environmental commitments will be implemented during the construction phase of the development so as to minimise CO_2 emissions: • Materials required for the construction works will be sourced locally where possible. There are operational quarries located in proximity to the proposed road development. Rock crushing will be undertaken on site where possible, to reduce the requirement to import crushed stone to site. • The Construction Traffic Management Plan outlined in the CEMP in **Appendix A.7.5** will be implemented in full. This will minimise congestion and encourage car sharing and the use of public transport. • Materials will be handled efficiently on site to minimise the waiting time for loading and unloading, thereby reducing potential emissions. • Engines will be turned off when machinery is not in use.

Ref No.	Stage	Commitments
		• The regular maintenance of plant and equipment will be carried out. • Materials with a reduced environmental impact will be used where available, such as: Ground Granulated Blast Furnace Slag (GGBS) and Pulverished Fly Ash (PFA) will be used as replacements for Portland cements and Recycled steel.
16.11	C	The Contractor will be required to implement an Energy Management System for the duration of the works. This will include the following at a minimum: • Use of thermostatic controls on all heating systems in site buildings. • The use of insulated temporary building structures. • The use of low energy equipment and power saving functions on all computer systems. • The use of low flow tap fittings and showers. • The use of solar/thermal power to heat water for the on-site welfare facilities including sinks and showers.

21.7 Noise and Vibration

Ref No.	Stage	Commitments
17.1	C	The Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Noise and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001. These measures will ensure that: • No plant used on site will be permitted to cause an ongoing public nuisance due to noise. • The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations. • All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract. • Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers. • Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use. • Any plant, such as generators or pumps that is required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen. • During the course of the construction programme, the Contractor will be required to manage the works to comply with the limits detailed in Table 17.1 using methods outlined in BS 5228-1:2009+A1 2011. Part 1 – Noise.
17.2	C	The Contractor will be required to conduct construction noise predictions prior to works taking place and put in place the most appropriate noise control measures depending on the level of noise reduction required at any one location.

Ref No.	Stage	Commitments
17.3	C	The potential for any item of plant to generate noise will be assessed prior to the item being brought onto the site. The least noisy item of plant will be selected wherever possible. Should a particular item of plant already on the site be found to generate high noise levels, the first action will be to identify whether or not said item can be replaced with a quieter alternative.
17.4	C	For static plant such as compressors and generators used at work areas such as construction compounds etc., the units will be supplied with manufacturers' proprietary acoustic enclosures where possible.
17.5	C	The Contractor will evaluate the choice of piling, excavation, breaking or other working method taking into account various ground conditions and site constraints. Where possible, where alternative lower noise generating equipment that would economically achieve, in the given ground conditions, equivalent structural/ excavation/ breaking results, these will be selected to minimise potential disturbance.
17.6	C	If replacing a noisy item of plant is not a viable or practical option, consideration will be given to noise control "at source". This refers to the modification of an item of plant, or the application of improved sound reduction methods in consultation with the supplier or the best practice use of equipment and materials handling to reduce noise. In practice, a balance may need to be struck between the use of all available techniques and the resulting costs of doing so. It is therefore proposed to adopt the concept of "Best Available Techniques", as defined in EC Directive 96/61.
17.7	C	Proposed noise mitigation techniques will also be evaluated in light of their potential effect on occupational health and safety. The following outline guidance relates to practical noise control at source techniques which relate to specific site considerations: • For mobile plant items such as cranes, dump trucks, excavators and loaders, the installation of an acoustic exhaust and/or maintaining enclosure panels closed during operation can reduce noise levels by up to 10dB. Mobile plant will be switched off when not in use and not left idling. • For piling plant, noise reduction can be achieved by enclosing the driving system in an acoustic shroud. For steady continuous noise, such as that generated by diesel engines, it is possible to reduce the noise emitted by fitting a more effective exhaust silencer system or utilising an acoustic canopy to replace the normal engine cover. • For percussive tools such as pneumatic concrete breakers, rock drills and tools a number of noise control measures include fitting muffler or sound reducing equipment to the breaker 'tool' and ensuring any leaks in the air lines are sealed. Erection of localised screens around breaker or drill bit when in operation in close proximity to noise sensitive boundaries are other suitable forms of noise reduction. • For concrete mixers, control measures will be employed during cleaning to ensure no impulsive hammering is undertaken at the mixer drum. • For all materials handling, the Contractor will ensure that best practice site noise control measures are implemented including ensuring that materials are not dropped from excessive heights and drop chutes/dump trucks are lined with resilient materials. This is an important consideration for site compounds where materials are loaded and unloaded. Site compounds in close proximity to noise sensitive areas (refer to **Table 17.10** of **Chapter 17, Noise and**

Ref No.	Stage	Commitments
		Vibration) will incorporate a strict noise control policy relating to materials handling. • Where compressors, generators and pumps are located in areas in close proximity to noise sensitive properties/ areas and have potential to exceed noise criterion, these will be surrounded by acoustic lagging or enclosed within acoustic enclosures providing air ventilation. • Resonance effects in panel work or cover plates can be reduced through stiffening or application of damping compounds; rattling and grinding noises can be controlled by fixing resilient materials in between the surfaces in contact. • Demountable enclosures can also be used to screen operatives using hand tools and may be moved around site as necessary. • All items of plant will be subject to regular maintenance. Such maintenance can prevent unnecessary increases in plant noise and can serve to prolong the effectiveness of noise control measures.
17.8	C	As per *BS 5228 -1:2009+A1* screens on level sites shall be placed as close as possible to either the source or the receiver. The construction of the barrier will be such that there are no gaps or openings at joints in the screen material. Annex B of *BS 5228-1:2009+A1:2014* (Figures B1, B2 and B3) provide typical details for temporary and mobile acoustic screens, sheds.
17.9	C	The Contractor will carefully plan the site layout. Within site compounds, the placement of site buildings such as offices and stores between the site and sensitive locations can provide a good level of noise screening. Similarly, in some instances materials such as topsoil or aggregate along the route of the proposed road development can provide a degree of noise screening if placed between the source and the receiver.
17.10	C	Construction activity will mostly take place during daytime hours Monday to Friday and Saturdays (ref **Section 17.2.2.1** of **Chapter 17, Noise and Vibration**). Depending on the noise emission levels experienced and associated noise impact, the Contractor will be flexible and able to conduct certain works at hours which reflect periods when the neighbouring properties have lower sensitivities to noise.
17.11	C	It will be necessary to work overtime (including weekends) and night shifts at certain critical stages during the project. Over the expected 36-month construction phase there will be up to 10 weeks of night time working along different sections of the proposed road development primarily to facilitate bridge works over existing roads.
17.12	C	Consideration will be given to the scheduling of activities in a manner that reflects the location of the site and the nature of neighbouring properties. Each potentially noisy event/activity will be considered on its individual merits and scheduled according to its noise level, proximity to sensitive locations and possible options for noise control. In situations where a particularly noisy activity is scheduled e.g. activities identified in **Table 17.9** of **Chapter 17, Noise and Vibration** (rock breaking/crushing/impact piling etc.) or other activities of similar noise level, the use of other on-site activities will be scheduled to control cumulative noise levels.
17.13	C	A designated noise liaison officer will be appointed to site during construction works to establish a clear form of communication between the Contractor and residents or building occupants in noise sensitive areas. All noise complaints will be logged and followed up in a prompt fashion by the liaison officer.

Ref No.	Stage	Commitments
17.14	C	During the construction phase noise monitoring will be undertaken at the nearest sensitive locations to ensure construction noise limits outlined in **Table 17.1** are not exceeded. Noise monitoring will be conducted in accordance with the International Standard ISO 1996: Acoustics – Description, measurement and assessment of environmental noise Part 1 (2016) and Part 2 (2017). The selection of monitoring locations will be based on the nearest sensitive buildings to the working area which will progress along the length of the road construction. It is recommended that noise control audits are conducted at regular intervals throughout the construction programme in conjunction with noise monitoring. In the case of vibration monitoring during construction the use of independent monitoring will be undertaken by external bodies for verification of results. Monitoring will be undertaken at identified sensitive buildings, where proposed works have the potential to be at or exceed the vibration limit values.
17.15	C	In terms of blast design control, specific guidance will be obtained from the recommendations contained within BS 5228-2:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Vibration in relation to blasting operations in addition to experienced blast control techniques used by the Contractor. These will include some or all of the following: • All blasting will be undertaken by professionally trained blast contractors. • Restriction of hours within which blasting can be conducted (09:00 – 18:00hrs). • Trial blasts will be tested in less sensitive areas to assist in blast designs and identify potential zones of influence. • Explosive charges will be properly confined by a sufficient amount of stemming. • Blasting contractors will ensure that the minimum amount of primer cord is used, and that no primer cord is located above ground. • Profiling will be carried out after each blast in order to ensure the geometry of the rock face can be established, enabling the optimum burden and spacing to be applied for subsequent blasts. • The design, execution and completion of any blasting within 150 metres of any existing structure shall require special considerations. This will include the use of pre and post condition structural surveys by a competent structural engineer. • Ground vibration and air over pressure (AOP) will be recorded simultaneously for each blast at the most sensitive locations, depending on the works area being blasted. • When blasting moves into a new area, an initial low level blast will be carried out (i.e. a low Maximum Instantaneous Charge (MIC)) and monitoring will be carried out simultaneously at a number of sensitive properties in different directions in order to generate specific scaled distance graphs. • The scaled distance graphs will be used to determine the optimum MIC for subsequent blasts area in order control vibration and AOP limits below the relevant limit values (as set out in **Section 17.2.1**) at the nearest sensitive buildings.
17.16	C	In line with best practice mitigation measures from vibration sources, good communication and public relations are a key factor in reducing any startle effects to residents. In this instance, a Public Communications Strategy

Ref No.	Stage	Commitments
		will be implemented by the Contractor prior to the commencement of any blast works. In such cases, the following recommended environmental commitments are proposed: • Relevant nearby residents will be notified before any work and blasting starts (e.g. a minimum of 24-hour written notification). • The firing of blasts will be undertaken, where possible, at similar times to reduce the 'startle' effect. • Ongoing circulars will be issued informing people of the progress of the blasting works. • The implementation of an onsite documented complaints procedure will be maintained by the Contractor. • The use of independent monitoring will be undertaken by external bodies for verification of results.
17.17	C	Vibration from construction activities should be limited to the values set out in **Table 17.3** of **Chapter 17, Noise and Vibration**.
17.18	C	In the case of vibration levels giving rise to human discomfort, in order to minimise such impacts, the following measures shall be implemented during the construction period: • A clear communication programme will be established to inform adjacent building occupants in advance of any potential intrusive works which may give rise to vibration levels likely to exceed perceptible levels. The nature and duration of the works will be clearly set out in all communication circulars. • Alternative less intensive working methods and/or plant items shall be employed, where feasible. • Appropriate vibration isolation shall be applied to plant, where feasible. • Cut off trenches to isolate the vibration transmission path shall be installed where required. • In the case of impact piling or demolition works for instance, a reduction in the input energy per blow shall be considered where required. • Monitoring will be undertaken at identified sensitive buildings, where proposed works have the potential to be at or exceed the vibration limit values.
17.19	C	Property condition surveys will be offered for all buildings within 50m of the proposed development boundary and those within 150m of proposed blasting works along the proposed road development. Property condition surveys will also be carried out at buildings and structures considered appropriate relative to their proximity to the works. Such property condition surveys shall be carried out by a Chartered Surveyor or Chartered Structural Engineer. Such property condition surveys, subject to the written agreement of relevant property owners, shall be carried out in two stages as the follows: • the first stage shall consist of pre-construction condition surveys including photographic records which shall be carried out prior to the commencement of construction. • the second stage shall consist of post-construction condition surveys which shall include photographic records.
17.20	C	The location of potentially vibration sensitive activities have been identified for manufacturing facilities within the Parkmore and Racecourse

Ref No.	Stage	Commitments
		Business Parks. This location is in proximity to an area where blasting will take place as part of the proposed tunnel at Ballybrit. The most effective form of mitigation for this type of sensitive process is through on-going consultation with the property owners as the design and construction of the proposed road development progresses. This will involve baseline vibration monitoring and the use of trial blasts using an initial low level charge with simultaneously vibration measurements undertaken at the building. This information will be used to determine acceptable vibration levels for the facility relating to the sensitivity of the operating equipment. The results of this trial assessment will then set appropriate agreed limits values at the facility in question which will be monitored during subsequent blasts or other excavation methodologies. Where no safe limit is determined, the timing and scheduling of blasts will be undertaken in consultation with the facility when no sensitive operations are taking place. Given the short time period over which an individual blast takes place (i.e. a number of seconds), this approach is deemed to be feasible.
17.21	O	Low Noise Road Surface (LNRS) will be used to reduce noise generated at source.
17.22	O	Noise barriers as detailed in **Table 17.14** in **Chapter 17, Noise and Vibration** and **Figures 17.1.01** to **17.1.14** will be implemented to reduce noise levels along the propagation path between the source (proposed road development) and the specific receivers (houses, schools, churches etc.). These screens may be constructed as earth bunds, proprietary noise barriers or a combination of both.

21.8 Landscape and Visual

Ref No.	Stage	Commitments
12.1	C	Landscape mitigation proposals shall take account of the approaches and principles as set out in A Guide to Landscape Treatments for National Road Schemes in Ireland, in particular to Chapter 4: Components of the Roadside Landscape; Chapter 5: Soil Geographic Factors; and Chapter 6: Landscape Treatments. Unless otherwise qualified in the following or in Chapter 8, Biodiversity, seeding and planting proposals, including species and planting type and species shall be in accordance with Chapter 6 of the Landscape Guidelines (A Guide to Landscape Treatments for National Road Schemes in Ireland) adapted as required for local environmental and landscape conditions.
12.2	C	Site machinery shall operate within the proposed road development construction area.
12.3	C	Storage areas shall be located so as to avoid impacting further on existing residential and other property, woodlands, trees, hedgerows, drainage patterns, etc.
12.4	C	Solid site hoarding of minimum 2.0m in height shall be provided alongside construction works adjoining residential property or recreational amenities
12.5	C	Solid hoarding or similar, of minimum 2.0m in height shall be provided along any side of a proposed construction compound, where they are located within 100m of residential properties.
12.6	C	Construction compounds shall be fully-decommissioned and reinstated to their pre-construction condition at the end of the construction contract

Ref No.	Stage	Commitments
		unless these areas have been identified as habitat compensation or material deposition areas.
12.7	C	Side slopes and other landscape areas along the proposed road development shall be prepared for soiling, and either seeded and/or planted at the earliest possible opportunity. As such, some scope may exist for undertaking significant areas of seeding and planting prior to the end of the construction works. However, due to construction programming and seasonal restrictions, it is also likely that significant planting works will not be undertaken until the end of the major construction phase.
12.8	C	All mitigation planting will take place at the earliest opportunity feasible during the construction stage so as to maximise establishment prior to road opening.
Project Wide Measures		
12.9	O	Cut slopes on mainline, link roads and local roads: Cut slopes shall be finished to even gradients, topsoiled unless otherwise stated in this table or elsewhere in the EIAR. Slopes shall be free of rubble and stones over 50mm diameter. All such rubble/stone shall be removed or buried. Unless otherwise stated slopes shall be seeded to a low maintenance non-agricultural grassland or to a diverse grass/wildflower sward, as appropriate. Steep slopes may be hydro-seeded. Where exposed, stable rock cuttings/slopes will be retained as a landscape feature along the proposed road corridor.
12.10	O	Embankments on mainline, link roads, and local roads: Embankments shall be finished to even gradients, topsoiled unless otherwise stated in this table or elsewhere in the EIAR. Slopes shall be free of rubble and stones over 50mm diameter. All such rubble/stone shall be removed or buried. Unless otherwise stated slopes shall be seeded to a low maintenance non-agricultural grassland or to a diverse grass/wildflower sward, as appropriate. Steep slopes may be hydro-seeded.
12.11	O	Verges & Roundabouts on mainline, link roads, and local roads: Verges will be provided along both sides of mainline. Verges will also be provided around junctions and along local road re-alignments and tie-ins. Verges and roundabouts shall be finished to even or gently flowing gradients, with minimum 200mm topsoil. Areas shall be stone buried or raked will be free of rubble and stones over 25mm diameter. Verges and roundabouts will be seeded to low-maintenance seed mix.
12.12	O	Ponds, swales, ‘V-drains’ etc.: All slopes shall be evenly graded and free of rubble and stones over 50mm diameter. Slopes shall be seeded to low maintenance non-agricultural grassland or to a grass/wildflower sward, allowing for natural development over time. Steep slopes on pond edges and ‘V-drains’ may be hydro-seeded. Areas around ponds shall be a diverse landscape of low maintenance grassland/species-rich grass wildflower sward and plantings of scrub planting and/or low-canopy woodland and shrub planting. Hedgerows of blackthorn and hawthorn, hazel and holly, without tree species, shall be established along non-roadside boundaries. Non-palisade type fencing shall be secure pond areas.

Ref No.	Stage	Commitments
12.13	O	Noise barriers/bunds: Where possible hedgerow scrub and shrub planting and/or low-canopy woodland of native species shall be established as either a narrow planting of 3.0m minimum width or double-staggered hedgerow along the full off-road face of barriers. Low-canopy and/or shrub planting of native species shall be established on the off road face of bunds. The planting shall include ash*, birch, blackthorn, elder, hawthorn, hazel, holly, rowan and/or willow species as appropriate. Plants shall be 90 to 120cm in height at planting. *** Note**: Due to the risk of Ash Dieback (*Chalara fraxinea*) and until further notice, ash (*Fraxinus* species) is no longer approved by the TII for planting schemes. This does not impact on the use of Mountain ash – also known as rowan (*Sorbus aucuparia*). Transparent noise barriers will be used on the River Corrib Bridge.
12.14	0	Plants and planting areas: All tree species over 150cm in height together with all Pine shall be appropriately staked and tied. All failed, dead or defective plants shall be replaced before the end of each and every year of defect aftercare. Full planting area will be free of stones over 50mm in diameter.
12.15	O	Grass areas: Grass areas shall provide full sward cover within 12 months of seeding. Any failed, bare or defective areas shall be re-seeded between March – May and/or August – September in each and every year of defect aftercare.
12.16	O	Unauthorised access, parking and/or encampment: Landscape proposals shall avoid creating areas considered as being suitable for unauthorised parking and shall use landscape proposals to deter and prevent such use.
12.17	O	Remnant areas: Any post-construction remnant lands shall be treated to a diverse range of grassland and/or planting proposals to include a minimum 30% planting, amended as locally appropriate. The remaining area shall be treated as locally appropriate low maintenance grass/species-rich sward.
12.18	O	Where feasible landscape measures shall include for the re-connection of existing field boundaries and hedgerows along the proposed road development. Where appropriate trees species as noted in Mitigation Tables 12.7 and 12.8 of the EIAR, shall be randomly spaced in a visually naturalistic manner within such hedgerows.
12.19	O	Where areas are in cut or fill, a grass or meadow sward will be established over the slope except in areas of cutting through stable rock (see Landscape Guidelines, Section 4.2: Cuttings and Embankments). Except where otherwise required, it is not proposed to plant either cut or fill slopes in their entirety, but to encourage a more naturalistic and locally sympathetic grouping of plantings within a semi-natural grass sward. Slopes may also be seeded to wildflower grassland and hydro-seeding may be utilised for seeding of steep slopes. It is expected that significant extent of rock cutting will arise on the proposed road development. Stable rock slopes will be retained as an exposed face for natural colonisation and as a local landscape features.
12.20	O	Along the length of the proposed road development, landscape areas within junctions and small areas of severed fields, plots or other property

Ref No.	Stage	Commitments
		acquired for the construction of the proposed road development will be varyingly treated including being planted in a semi-natural copse like scrub plantings and native woodland species. (see Landscape Guidelines, Section 4.6: Additional Plots and Other Areas). Such planted blocks dispersed along the proposed road development will assist in the improvement of the longer-term visual character of the proposed road development and local surrounds. Particular attention shall be given to an appropriate extent and scale of planting in and surrounding junctions (see Landscape Guidelines, Section 4.3: Junctions, Interchanges and Roundabouts) and embankments (see Landscape Guidelines, Section 4.2.2: Embankments).
12.21	O	Certain areas along the length of the proposed road development have been set aside for drainage requirements/pollution control/attenuation. Where proposed these will be securely fenced and planted with locally appropriate hedgerows, shrubs and/or screen planting located along the proposed development boundary to minimise any visual impact from off road areas. However, it is noted that these features also offer the potential to provide for improved landscape diversity and habitat.
12.22	O	Proposed planting will generally be established using bare-root transplants, whips and feathered plants which adapt readily to disturbed ground conditions. A proportion, totalling not less than 5% of ‘Half-standard’ (6-8cm girth & 200cm-250cm tall) and a further 5% ‘Standard’ (8-10cm girth & 250cm-300cm tall) trees shall be used to supplement these plantings, especially in the vicinity of residential areas. All planting mixes will take cognisance of, and include native and local species as identified in the **Chapter 8, Biodiversity**. These requirements have been adapted and further detailed as appropriate to particular areas as set out in **Table 12.8** of **Chapter 12, Landscape and Visual** of the EIAR.
12.23	O	Where used, tree species will be selected from a list of primarily native, naturalised and indigenous species, which will include alder, common ash (subject to planting restrictions at time of works), common birches, common oaks, mountain ash, Scots pine and willow species. Planting sizes will be from 75cm to 400cm in height and tree species will be planted at average 2.0m centres within the wider planting mix.
12.24	O	Shrub planting species utilised will be selected from a list of primarily native and indigenous species, which will include, blackthorn, elder, hawthorn, hazel, holly, guelder rose, spindle, willows and other plants found naturalised in the affected localities. Planting sizes will vary from 30 to 75cm in height and shrub species will be planted at between 1.0 and 1.5m centres depending of landscape type, see **Table 12.8** of the EIAR.
12.25	O	Hedge planting will be primarily of blackthorn and hawthorn interspersed with other species such as elder, hazel, holly and those found locally. Hawthorn within hedgerows shall be planted at between 75 to 90cm in height and at 500mm centres in each of 2 double staggered rows or wider plantings where a denser effect is required. The hedgerow will be interspersed with standard-sized randomly spaced tree species such as alder, common ash and oaks, as appropriate to particular locality.
12.26	O	Areas to be seeded to meadow will be thinly topsoiled (5cm layer) and seeded with a locally appropriate seed mix. Mainline and side road verges will be cultivated, topsoiled minimum 200mm deep and stone buried to remove stones down to 25mm diameter prior to seeding to a low-maintenance grass seed mix.

Ref No.	Stage	Commitments
12.27	O	Where lighting is proposed, the lighting design shall meet the requirements of BS EN 13201-2:2003 and BS5489-1: 2003, Code of Practice for Design of Road Lighting. Lighting of Roads and Public Amenity Areas and shall comply with the requirements of the DMRB TD 34-91. The detailed lighting design shall be completed in a manner, which will minimise glare and will ensure that light-spill effect is minimised.
Specific Measures		
12.28	O	In specific locations barriers and/or earth bunds may be provided to reduce the impact of noise. Such features shall, wherever possible, be integrated within the proposed landscaping measures.
12.29	O	All of the following specific environmental commitments will be taken account of in the detailed design and implementation of landscape measures: • Location of cut-off drains at the top of cuttings and at the bottom of embankments. • The location and requirements for maintenance access along the mainline of the proposed road development. • Locations where rock is encountered in cuttings. Such rock faces may be retained as geological features of the corridor of the proposed road development. • The location and integration of noise barriers within the landscape design. • Clearance zones (TD19 - Safety Barrier Standards). • Sight-lines, including at junctions and to carriageway signage, etc.
12.30	O	Where feasible reinforced earth retaining wall approaches will be incorporated so as allow for a green landscape finish to all or part of the retaining structures. A limestone finish will be used where structural walls are required and for the abutments of the proposed bridge over the N59 Moycullen Road. The stone will consist of natural limestone, matching the character of the local stone, with a strong horizontal axis of between 5 to 1 and 7 to 1 (i.e. horizontal to vertical dimension).
12.31	O	Landscape Measures also take account of the specific protection and environmental commitments detailed in **Chapter 8, Biodiversity**. In particular, the measures include: • Retained habitats, trees and hedgerows on land-take boundaries, etc. will be fenced-off and protected during construction works. • Specific measures are proposed at a number of locations for mitigation of potential impact on Bat species. This includes: o the provision of artificial bat roosts – with specific planting to encourage use. o the provision of a planted wildlife overbridge (Ch. 12+700) with tie-in planting to local hedgerows and proposed planting on the boundary of the proposed road development, which will maximise potential benefit and use. o dense planting, with trees for improvement of connectivity along the boundary of the proposed road development: o west of the crossing of the L1323 Letteragh (Ch. 7+200 – Ch. 7+280). o along embankments to either side of the proposed bridge over the River Corrib.

Ref No.	Stage	Commitments
		o between the crossing of the N84 Headford Road at Ballindooley and School Road at Castlegar. o hedgerow planting for improvement of connectivity of habitats to the east of Menlo Castle. o hedgerow and copse planting for enhancement of foraging habitat to the north of Menlo Castle. • In order to deter Barn Owls from foraging close to the proposed road development, embankments and cuttings, other than rock cuttings or cut slopes left to naturally regenerate, will be densely planted with low growing scrub (e.g. blackthorn, hawthorn) from Ch. 8+550 to Ch. 17+500. • In order to deter Barn Owls from over flying the proposed road development, planting of closely-spaced trees (approx. 2m centres) greater than 3m in height will be established along the top of the embankments between Ch. 9+600 and Ch. 10+100.
12.32	O	6.0m wide Screen Planting (Planting at 1.0m centres for visual screening shall be of a minimum of 6m in width. The planting shall extend for a minimum of 100m to either side of any adjoining residential property or amenity. (refer to **Figures 12.4.01** to **12.4.14**)). • Planting will include a dense planting at 1m centres of alder, birch, blackthorn, elder, geulder rose, holly, hawthorn, hazel, rowan, and willow species. Shrubs shall be planted at between 60 to 90cm in height. • Scots pine of minimum 60cm in height at planting shall comprise 20% of the overall plant numbers and holly at a minimum of 45cm in height shall comprise a further 15%. • Tree species, planted equally at half-standard (6-8cm girth) and standard size (8-10cm girth), shall comprise minimum 10% of the mix.
12.33	O	3.0m wide Screen Planting (Where space is limited planting at 1.0m centres for visual screening shall be of a minimum of 3m in width. The planting shall extend for a minimum of 100m to either side of any adjoining residential property or amenity. (refer to **Figures 12.4.01** to **12.4.14**)). • Planting will include a dense planting at 1m centres of alder, birch, blackthorn, elder, geulder rose, holly, hawthorn, hazel, rowan, and willow species. Shrubs shall be planted at between 60 to 90cm in height. • Scots pine of minimum 60cm in height at planting shall comprise 20% of the overall plant numbers and holly at a minimum of 45cm in height shall comprise a further 15%. • Tree species, planted equally at half-standard (6-8cm girth) and standard size (8-10cm girth), shall comprise minimum 20% of the mix.
12.34	O	Stone Wall Boundaries (Stone walls as indicated on **Figures 12.4.01** to **12.4.14**). • Where indicated stone walls will be replaced along impacted sections of property and road boundaries on local roads. The stone from the disturbed sections of existing walls will be retained and re-used (generally granite to west; limestone to east) where possible to reinstate these new boundaries. The boundary walls may be backed by hedgerows of locally appropriate species, i.e. blackthorn, hawthorn and holly to west and hazel, hawthorn and holly to east. Elsewhere, where stone walls are removed the stone will be retained and made available for re-use by the adjacent property owners for

Ref No.	Stage	Commitments
		the construction of a new stone wall on their side of the proposed development boundary if they wish.
12.35	O	Boundary Hedgerow (Typical double staggered hedgerow with tree planting, where locally appropriate). • Primarily blackthorn (30%), hawthorn (40%) and holly (10%) hedgerow in west interspersed with other species (20%) such as elder, willow, and those found locally. • Primarily hazel (30%), hawthorn (40%) and holly (10%) hedgerow to east interspersed with other species (20%) such as blackthorn elder, willow, and those found locally. • Hawthorn plants shall be of c.90cm in height and planted at 50cm centres in each of two double staggered rows, 25cm apart. Other plants of c.50cm in height shall be interspersed. • The hedgerow may be interspersed with 'half-standard-sized' (6-8cm girth) alder, birch and/or oak trees planted at random spacings but averaging a min. of 1 tree per 25 linear metre. Limited tree species, such as birch and mountain ash may also be included as 'whips' at 150cm in height.
12.36	O	Retaining Walls and structure over the N59 Moycullen Road (Use of reinforced earth retaining systems and limestone finishes for structural elements. Retaining Wall Structures R08/01; R08/02; R08/07 & R08/04; and Bridge Structure S08/02 (Ch. 8+300 to Ch. 8+670)) • Where feasible reinforced earth retaining wall approaches will be incorporated so as allow for a green landscape finish to all or part of the retaining structures. • Planting of trees shall also be provided along the base of the structure. These shall include smaller growing species such as alder, birch and rowan planted as Selected Standards (i.e. 14cm girth or greater). • A limestone finish will be used for the external finish of the abutments for the proposed bridge over the N59 Moycullen Road and where structural walls are required. The stone will consist of natural limestone, matching the character of local stone, with a strong horizontal axis of between 5 to 1 and 7 to 1 (i.e. horizontal to vertical dimension).
12.37	O	Bat habitat enhancement (new 2m wide tree and shrub hedgerow, with occasional planted copses located north and east of Menlo Castle.) • New hedgerow of native species will be established with plants at 0.5m staggered centres in each of 5 rows located 0.5m apart to sub-divide existing open fields. • Standard-sized trees species (min 8-10cm girth, 2.4m high) will be planted at 15m staggered centres in each of the 3 central rows. Diverse range of shrub species will be planted between trees in the central rows and throughout the outer 2 rows. • Circa 15m diameter woodland copses will be established within open fields using similar approach, densities and species • Planting will be protected by stock-proof fence, c.1.25m high located at 1.0m offset to either side of the outer row of the new hedgerow. • Tree species to include alder, birch, oak, rowan, planted as standards (as above) and whips (1.25m high). Shrubs to comprise mainly blackthorn, hawthorn and hazel (combined 60%), with elder, holly, spindle, willow etc. • Hawthorn plants shall be of between c.90cm in height and all other shrubs shall be c.60cm in height.

Ref No.	Stage	Commitments
12.38	O	Wildlife Overpass (Ballindooley/Castlegar, Structure S12/02 (Ch. 12+700)) • Wildlife overpass (c.30m wide) will be landscaped to provide for connective habitat across proposed road development. Planting to consist of a central narrow grass path bounded on either side by tree-lined hedgerows of native species. • Soil depths to vary from minimum c.45cm depth at edges to c.1.5m depth along centre-line of both hedgerows. Planted element of both hedgerow lines will be c.2m wide with standard-sized trees (min 8-10cm girth, 2.4m high) planted at 3m staggered centres in each of 2 rows in each hedgerow. Diverse range of shrub species will be planted between trees and along the line of each hedgerow. • Planting to tie-in to proposed planting leading east and west on upper slopes of cuttings on both sides of the proposed road development. This will form a continuous hedgerow/planted network. • Tree species to include alder, birch, oak, rowan, planted as standards (as above) and whips (1.25m high). Shrubs to comprise mainly blackthorn, hawthorn and hazel (combined 60%), with elder, holly, spindle, willow etc. • Hawthorn plants shall be of between c.90cm in height and all other shrubs shall be c.60cm in height.
12.39	O	**Barn Owl Planting** <u>Typical double staggered treeline with dense under planting, between Ch. 9+600 and Ch. 10+100.</u> • Deterrent tree planting to comprise alder, birch and/or rowan planted at 3m in height (min 12-14cm girth) and at 2.0m centres in each of 2 rows 1.5m apart. • Dense low scrub planting to comprise blackthorn (50%), hawthorn (20%), hazel (10%) and holly (10%) hedgerow in the west interspersed with other species (10%) such as elder, willow, and those found locally. • Hawthorn plants shall be of c.90cm in height and planted at 50cm centres. Blackthorn and other plants shall be of c.50cm in height and planted at 50cm centres in staggered rows, 50cm apart. <u>Dense low scrub planting on all embankments and cut slopes (other than rock cuttings or cut slopes left to naturally regenerate) from Ch. 8+550 to Ch. 17+540.</u> • Dense low scrub planting to comprise blackthorn (50%), hawthorn (20%) hazel (10%) and holly (10%) interspersed with other species (10%) such as elder, willow, and those found locally. • Hawthorn plants shall be of c.90cm in height and planted at 50cm centres. Blackthorn and other plants shall be of c.50cm in height and planted at 50cm centres in staggered rows, 50cm apart. • Compensatory Habitat Areas (CHA) along the proposed road development will be as detailed in **Appendix A.8.26**.

21.9 Archaeology, Architectural and Cultural Heritage

Ref No.	Stage	Commitments
13.1	C	Archaeological monitoring and investigations will be undertaken as part of the site clearance works for the construction of the proposed road development in order to record and preserve any buried findings using the appropriate methods. This programme of archaeological test trenching will be carried out within the footprint of the proposed road development prior to construction going ahead. This will target the sites and areas of archaeological and cultural heritage potential as outlined in **Section 13.5.3** of **Chapter 13, Archaeology, Architectural and Cultural Heritage** as well as previously undisturbed areas within the proposed development boundary.
13.2	C	Test trenching will be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be identified, if that is deemed the most appropriate manner in which to proceed.
13.3	C	Prior to demolition, the thatched cottage BH 12 will be subject to a full measured, written and photographic survey. This will be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.
13.4	C	The demesne landscape associated with Menlo Castle (DL 8), at Dangan Lower (DL7) and at Bushypark House (DL4) will be subject to a detailed photographic and written record prior to the construction of the proposed road development. This will be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.
13.5	C	All Cultural Heritage (CH) sites listed in **Table 13.17** of **Chapter 13, Archaeology, Architectural and Cultural Heritage** that include built heritage remains will be subject to a detailed written and photographic survey (to include test trenching where appropriate). This shall be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be identified, if that is deemed the most appropriate manner in which to proceed.
13.6	C	Archaeological wade or underwater assessments will be carried out at any natural water courses (AAPs) to be impacted upon by the proposed road development by disturbance to their banks or beds. This shall be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be identified, if that is deemed the most appropriate manner in which to proceed.
13.7	C	Any section of Townland Boundary to be impacted upon will be subject to a detailed written and photographic survey (to include test trenching where appropriate). This shall be carried out under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. Full provision will be made available for the excavation of any archaeological features and/or deposits that may be

Ref No.	Stage	Commitments
		identified, if that is deemed the most appropriate manner in which to proceed.
13.8	C	Excavation of all previously recorded archaeological sites – where these fall, in whole or in part, within the footprint of the development – will be carried out under Ministerial Direction in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.
13.9	C/O	Archaeological sites (AH) 15, 16, 29, 11, 12, 23 and 26 will be subject to a detailed photographic and written landscape record to preserve their current setting prior to the construction and operation of the proposed road development. This shall be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.
13.10	C/O	Protected Structures (BH) 1, 7, 9, 10 and 17 will be subject to a detailed photographic and written landscape record to preserve their current setting prior to the construction and operation of the proposed road development. This shall be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.
13.11	C/O	Cultural Heritage Sites (CH) 20, 23, 8, 25, 30, 35, 42 and 54 will be subject to a detailed photographic and written landscape record to preserve their current setting prior to the construction of the proposed road development. This shall be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist.

21.10 Soils and Geology

Ref No.	Stage	Commitments
9.1	C	Construction techniques that comply with the requirements of statutory bodies in terms of noise, vibration, soil and groundwater contamination and disposal of contaminated material for both soil and rock cuttings will be adopted.
9.2	C	All excavated material, excluding a small potential volume of hazardous material, will be re-used as construction fill and material deposition areas minimising the loss of the feature. The Contractor will ensure acceptability of the material for re-use within the proposed road development with appropriate handling, processing and segregation of the material.
9.3	C	A construction earthworks programme will be implemented as part of the CEMP included in **Appendix A.7.5**, which will be finalised by the Contractor, for the proposed road development which categorises the source of material for each fill section. During the finalisation of this programme, the fill limitations outlined below will be incorporated. To prevent impact to the local peatland habitats, the following fill limitations will be incorporated at the locations identified **Table 9.18** of **Chapter 9, Soils and Geology** • Only pavement and capping layers protected from surface water runoff and groundwater movements are permitted to be derived from non-native material

Ref No.	Stage	Commitments
		• All other acceptable fill material will be derived from native material or other pH compatible material
9.4	C	A drainage layer or starter layer, in accordance with the TII publication CC-SCD-00606, will be implemented for the construction of embankments in areas prone to flooding. The introduction of a drainage layer will ensure hydraulic conductivity exists across the flood plain and removes the risk of the embankment acting as a flood barrier.
9.5	C	Earthworks haulage will be along predetermined routes within and outside the proposed development boundary as shown on **Figures 7.101** to **7.123**. The identified haulage routes are along existing national, regional and local routes or within the proposed development boundary. Where compaction occurs due to truck movements and other construction activities on unfinished surfaces, remediation works will be undertaken to reinstate the ground to its original condition. Where practicable, compaction of any soil or subsoil which is to remain in-situ along the proposed road development will be avoided.
9.6	C	In the event the embankment will be constructed of local material, the introduction of a drainage layer or starter layer will reduce the likelihood of run-off of fine material. Alternatively, the introduction of a geotextile separator will reduce the potential impact in areas. A composite system, combining a drainage layer and a geotextile separator will be implemented in embankments constructed with cohesive fill material. Sediment control methods are outlined in the CEMP in **Appendix A.7.5**.
9.7	C	Ground settlement, horizontal movement and vibration monitoring will be implemented during construction activities to ensure that the construction does not exceed the design limitations. In situations where the site specific blast design has determined that blasting is not feasible in a particular location due to excessive ground vibrations, alternative extraction methods such as hydraulic breaking, hydraulic splitting, chemical splitting and electrical disintegration may be implemented and monitored. Monitoring will be implemented during blasting, during excavation of cuts, for overburden slopes steeper than 1V:2H (V= vertical slope, H = horizontal slope) and rock slopes steeper than 1V:1.5H. The Employer's Site Monitoring Team will be monitoring the reports on a weekly basis to ensure compliance with the commitments in relation to vibration limits.
9.8	C	A geotechnical expert will be appointed by the Contractor and will be present to monitor the surrounding ground vibrations near sensitive receptors during blasting works. The Employer's Site Monitoring Team will be monitoring the reports on a weekly basis to ensure compliance with the commitments in relation to vibration limits.
9.9	C	A trial blast, and will be carried out as part of a blast assessment. The monitored trial blast will be undertaken in the same bedrock formation by the blasting contractor in a controlled location, not exceeding the vibration limitations of the local sensitive receptors, posing no risk to sensitive receptors including Annex I habitat in Lough Corrib cSAC. The trial blast will calibrate the blast design to a site specific design. The blast target vibration limit is defined as 20% more conservative than the conservative design approach vibration limit of 25mm/sec at the ground surface which includes areas of Limestone pavement at Lackagh Tunnel. In addition, the Limestone pavement will be monitored during the tunnelling works for any effects from the blast vibrations. In the unlikely event that the blast target vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the

Ref No.	Stage	Commitments
		increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring. Allowable distances for the various construction methods are given in the section below on Noise and Vibration. The Employer's Site Monitoring Team will inspect the trial blast reports to check compliance with the limitation limits in vibration at surface.
9.10	C	Importation of materials from outside the site will be minimised by ensuring that materials arising within the site area are used to the greatest extent possible. Any surplus material remaining which cannot be incorporated into the construction fill activities shall be placed in material deposition areas within the proposed road development. Hazardous material will be transported off site for disposal or recovery at appropriately licence or permitted sites as outline above for Construction Activities.
9.11	C	Construction of structures will be completed in accordance with the CEMP in **Appendix A.7.5**. The construction of the River Corrib Bridge will meet the requirements of the: River Corrib Bridge Constructability Examination **Appendix A.7.1**; the Menlough Viaduct will meet the requirements of the Menlough Viaduct Constructability Examination **Appendix A.7.2**, the Lackagh Tunnel will meet the requirements of the Lackagh Tunnel Geotechnical and Hydrogeological Appraisal **Appendix A.7.3** and the Galway Racecourse Tunnel will meet the requirements of the Galway Racecourse Tunnel Constructability Report **Appendix A.7.4**. The adopted construction techniques will comply with the requirements of statutory bodies in terms of noise, vibration, soil and groundwater contamination and disposal of contaminated material.
9.12	C	For the construction of Lackagh Tunnel a hydrogeology and geotechnical expert will be appointed by the Contractor and will be present to monitor at all times when the construction activities have the potential to impact on groundwater or the Annex I habitats at the surface, namely Limestone pavement and Calcareous grassland. This includes the supported rock face of Lackagh Quarry Face and retaining walls for the Western Approach. Monitoring of the exposed rock slopes and retaining walls will be carried out during construction and operation to ensure there is no impact to the Annex I habitat. In the extremely unlikely event that instability is observed additional support measures will be installed to ensure that there is no impact to the Annex I habitat. The additional support measures comprise ground anchors, rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures, designed to the relevant design standards (Eurocode 7, BS8081) and best practice guidance documents. The Employer's Site Monitoring Team will review weekly monitoring reports to check stability of rock slopes in Lackagh Quarry.
9.13	O	The rock and overburden retaining systems in Lackagh Quarry and Western Approach will continue to be monitored as part of the TII (Transport Infrastructure Ireland) maintenance schedule to ensure that they continue to operate as intended for the design life of the proposed road development. In the extremely unlikely event that instability within the rock mass is observed additional support measures (e.g. rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures will be

Ref No.	Stage	Commitments
		installed to ensure that there is no impact to the structural integrity[1] of the Limestone pavement.
9.14	C	Ground settlements will be controlled through selection of the foundation type and method of construction which are suitable for the particular ground conditions. To minimise soil movements due to pile operations in the vicinity of sensitive receptors, each pile shall be constructed sequentially in a direction away from the sensitive receptor. Previously installed piles act as a shield as soil movements are greater in a direction away from the stiffer zone i.e. away from the piles and sensitive receptors.
9.15	C	During construction, the Limestone pavement at Menlough Viaduct will be protected and will not be impacted by implementing a protection system comprising of geogrid, protection geotextile and layers of material. Refer to Menlough Viaduct Constructability Report in Appendix A.7.2 for further details.
9.16	C	Samples of ground suspected of contamination will be tested for contamination during the detailed investigation and ground excavated from these areas will be disposed of to a suitably licence or permitted sites in accordance with the current Irish Waste Management legislation.
9.17	C	Good housekeeping (daily site clean-ups, use of disposal bins, etc.) on the site, and the proper use, storage and disposal of these substances and their containers will prevent soil contamination. For all activities involving the use of potential pollutants or hazardous materials, material such as concrete, fuels, lubricants and hydraulic fluids will be carefully handled and stored to avoid spillages. Potential pollutants shall also be adequately secured against vandalism and will be provided with proper containment according to codes of practice. Any spillages will be immediately contained and contaminated soil removed from the site and disposed of to an appropriately permitted or licenced site according to the current Irish Waste Management Legislation by the Contractor.
9.18	C	The Contractor is required to make provision for removal of any concrete wash water. Concrete trucks will be directed back to their batching plant for washout. The arrangement for concrete deliveries to the site will be discussed with suppliers before commencement of work, outlining the agreed assessed routes, prohibiting on site washout and discussing emergency procedures.
9.19	C	As a minimum, the carriageway drainage network will be sealed in areas where the proposed road development crosses rock particularly prone to karstification. Through the use of engineered solutions, including an impermeable barrier, cement slurry or grout, direct run-off from the paved surface of the proposed road development will be prevented from entering into the rock along the proposed alignment, as this could cause further deterioration and instability of the rock mass. Individual mitigation measures will be assessed on a case by case basis, determined by the extent of karst and make-up of the proposed road development as outlined in the karst protocol which is part of the CEMP in **Appendix A.7.5**. Inspections of karst features will be undertaken by a hydrogeologist and/or geotechnical expert in order to determine the appropriate remediation measure. These remedial measures include but are not limited to the removal of all loose, soft, weak or voided soil material, backfilling voids with an agreed combination of boulders cobbles / chunk rock / cement

[1] Structural Integrity of the rockmass that supports the mosaic of Limestone pavement and Calcareous grassland is the physical and mechanical geotechnical properties that control the behaviour of the geotechnical Limestone pavement environment

Ref No.	Stage	Commitments
		slurry and installation of a high strength geosynthetic to form a competent, safe foundation platform.

21.11 Hydrogeology

Ref No.	Stage	Commitments
10.1	C	No dewatering will occur during construction at Menlough Viaduct or Lackagh Tunnel (or its approaches). Furthermore, the construction sequence will take into account the seasonal groundwater fluctuation. During the winter groundwater high it may be necessary to limit the depth of works so that dewatering is not required.
10.2	C	Galway Granite Batholith EW01, 02 (three cuttings), 04, 07 and 09: Groundwater intercepted will be collected and piped to the surface water receptor it would naturally have drained to.
10.3	C	Limestone: Construction dewatering of the bedrock aquifer may seasonally be required in EW27 during peak groundwater levels. Any dewatering will be discharged to the same groundwater body.
10.4	C	Construction of the Galway Racecourse Tunnel and its approaches will require dewatering of the bedrock aquifer. All groundwater intercepted will be managed and discharged within the same groundwater body.
10.5	C	EW27: Groundwater will be controlled within the excavation by collection in drains or sumps. If groundwater is intercepted, it will be piped and discharged at an infiltration basin within the same groundwater body. Intercepted groundwater is controlled and infiltrates back to the same groundwater body.
10.6	C	Where infiltration basins are used for discharge of site runoff during construction the runoff will be managed on site, collected and treated as per the Sediment Erosion and Pollution Control Plan (Refer to Section 8 of the CEMP in **Appendix A.7.5**).
10.7	C	Infiltration basin S19a and S19b include lining the sides of the excavation to ensure vertical groundwater infiltration so that all discharges drain through the placed subsoil for the full thickness of the unsaturated zone.
10.8	C	The following measures included in the CEMP will be implemented to control the potential for pollution from accidental spillages on site: • Stockpiling of contaminated material is not permitted. • Good housekeeping on the site during construction, and the proper use, storage and disposal of these substances and their containers will prevent groundwater contamination. • For all activities involving the use of potential pollutants or hazardous materials, under the CEMP, the Contractor will be required to ensure that material such as concrete, fuels, lubricants and hydraulic fluids will be carefully handled and stored to avoid spillages. Potential pollutants shall also be adequately secured against vandalism and will be provided with proper containment according to codes of practice. Any spillages will be immediately contained and contaminated soil removed from the site and properly disposed of. • The Contractor will finalise the Incident Response Plan in the CEMP in **Appendix A.7.5** prior to work commencing and regularly update it for pollution emergencies which will be developed by the appointed

Ref No.	Stage	Commitments
		Contractor. The Contractor shall implement all the measures detailed in Incident Response Plan.
10.9	C	In the event of karst being encountered the Karst Protocol shall be implemented, which is documented in the CEMP (**Appendix A.7.5**): • Where karst features are encountered during construction works these will be assessed by a hydrogeologist and an engineering geologist. In the case of excavations (road cuttings, tunnels, bridge pier excavations) then the karst feature shall be excavated and backfilled with course fill and sealed. • With regard to karst features being intercepted in excavations for earthworks (including viaducts, bridges and tunnels) and infiltration basins. The Karst Protocol preserves the hydraulic connectivity of the feature using granular material to fill but then seals the karst from the excavation using a liner (geotextile and or concrete depending on the site specifics). • Where dewatering of the bedrock aquifer is proposed, groundwater level monitoring will be installed before construction, during the construction phase and 12 months following construction to enable potential effects from dewatering to be identified. If the monitoring indicates there is a measurable impact beyond that stated in this EIAR, then work with the potential to increase drawdown will be made safe and cease until the hydrogeological assessment is revised based on the site conditions and mitigation employed if appropriate. • In order to reduce potential contamination impacts, stockpiling of contaminated material and leachate generation will be prohibited. In the situation that potential contaminated material is encountered it will be tested and disposed of in an appropriate manner and in line with current water management legislation. If it is not possible to immediately remove contaminated material, then it will be stored on, and covered by, polythene sheeting to prevent rain water infiltrating through the material. The time frame between excavation and removal will be kept to an absolute minimum.
10.10	C	Five wells (W50-10, W50-12, W50-13, W50-14 and W50-15) will be lost during the construction of the proposed road development. These will each be mitigated by providing a replacement well, connecting to mains supply where available or by financial compensation. Where wells have to be abandoned as part of the proposed road development they will be sealed and abandoned in general accordance with Well Drilling Guidelines produced by the Institute of Geologists of Ireland (IGI 2007).
10.11	C	Replacement wells, storage tank, associated pumping equipment and pipework for Wells W50-13 and W50-14 will be commissioned and tested to ensure adequate yield rates in advance of wells W50-13 and W50-14 being decommissioned.
10.12	C	Wells outside of the proposed development boundary but within the drawdown zone of influence may be impacted by reduced groundwater levels during construction. All wells within 150m of the proposed development boundary (or 50m from the calculated drawdown ZoI if greater) will be monitored for water level on a monthly basis for 12 months before construction, during construction and for 12 months after construction. If the monitoring indicates that the proposed road development has impacted on a supply or geothermal well then mitigation will be applied.
10.13	C	To ensure the protection of quality of groundwater potable supplies, all wells within 150m of the proposed development boundary will be monitored for water quality on a monthly basis. All wells will be

Ref No.	Stage	Commitments
		monitored for standard drinking water quality parameters on a monthly basis for 12 months before construction, during construction and for 12 months after construction. If the monitoring indicates that the proposed road development has impacted on a supply, then mitigation will be applied.
10.14	C	The groundwater dependent terrestrial ecosystems (GWDTE) that have been flagged as being at risk are all in areas where the groundwater pathways are karstic. In this regard the Karst Protocol, as detailed above, forms part of mitigation to prevent groundwater quality or quantity being impacted. Additional mitigation is also employed to ensure that European sites are not impacted.
10.15	C	There will be no surface water discharges to the Coolagh lakes and all runoff will be treated before being discharged to ground at infiltration basins. Infiltration basins are designed to include settlement to remove sediment and have an appropriate thickness of subsoil below invert level.
10.16	C	Pouring of the concrete in excavations (River Corrib Bridge, Menlough Viaduct and Lackagh Tunnel) will only be undertaken when the excavation has been inspected by a qualified hydrogeologist. Inspection of the full depth and extent of each excavation will be undertaken to identify if any significant flow paths, such as the karst enhancement of the bedrock permeability, are present. If no significant flow paths are present, then the hydrogeologist will document accordingly and confirm that there is no risk to groundwater from concrete leakage. If significant pathways are present then impacts which may arise from flow along these pathways shall be designed by the hydrogeologist based on the karst mitigation plan, these may comprise of installing a high permeability zone to replace the groundwater pathways which would be removed by the foundations and/or sealing the linkage from excavation to protect the karst. The design of the mitigation measures shall be approved by a qualified hydrogeologist to confirm that there will be no negative impacts to groundwater.
10.17	O	During the operational phase of the proposed road development inspection and maintenance will occur to ensure that the infiltration basins continue to operate as intended for the design life of the proposed road development.
10.18	O	Infiltration basins require regular inspection to confirm that no observable subsidence in the infiltration has occurred due to karst. Inspection is recommended on 5-year frequency.
10.19	O	If karst features and potential pathways are found to be present during inspection, then the Karst Protocol developed for the construction phase will be implemented to ensure that no preferential pathways have formed within the infiltration basin.

21.12 Hydrology

Ref No.	Stage	Commitments
11.1	C	The CEMP included in **Appendix A.7.5** will be finalised by the Contractor in advance of the commencement of construction and the following will be implemented as part this plan: • An Incident Response Plan detailing the procedures to be undertaken in the event of spillage of chemical, fuel or other hazardous wastes, logging of non-compliance incidents and any such risks that could lead to a pollution incident, including flood risks. • A Sediment Erosion and Pollution Control Plan (Refer to Section 8 of the CEMP in **Appendix A.7.5**). This shall include water quality monitoring and method statements to ensure compliance with environmental quality standards specified in the relevant legislation. • All necessary permits and licenses for instream construction works associated with the provision of culverts, bridges and outfalls. OPW Section 50 consent has been received for all culverts and bridges proposed in the EIAR. Changes to these structures as part of the detailed design and construction stage will require new Section 50 consent to be obtained. • Inform and consult with OPW Western Arterial Drainage Section who have responsibility for the Corrib-Mask Arterial Drainage scheme and the ongoing control of river and lake levels at the Salmon Weir Barrage in Galway City. • Continue to inform and consult with Inland Fisheries Ireland (IFI). • Continue to inform and consult with National Parks and Wildlife Service (NPWS).
11.2	C	Construction activities will be required to take cognisance of the all relevant guidance documents for construction work on, over or near water including: • Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters (Inland Fisheries Ireland, 2016). • Shannon Regional Fisheries Board – Protection and Conservation of Fisheries Habitat with particular reference to Road Construction. • Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites (Eastern Regional Fisheries Board). • Central Fisheries Board Channels and Challenges – The Enhancement of Salmonid Rivers. • CIRIA C793 The SuDS Manual. • CIRIA C624 Development and Flood Risk – guidance for the construction industry. • CIRIA C532 Control of Water Pollution from Construction Sites Guidance for Consultants and Contractors. • CIRIA C648 Control of Water Pollution from Linear Construction Projects, technical guidance. • CIRIA C649 Control of Water Pollution from Linear Construction Projects, site guide. • Guidelines for the Crossing of Watercourses during the Construction of National Road schemes (NRA, 2006). • Road Drainage and the Water Environment DN-DNG-03065 (TII, June 2015).

Ref No.	Stage	Commitments
		Vegetated Drainage Systems for Road Runoff DN-DNG-03063 (TII, June 2015).
11.3	C	As set out in the Sediment Erosion and Pollution Control Plan (Refer to **Section 8** of the CEMP), the sediment, erosion and pollution controls will be monitored and maintained throughout the construction of the proposed road development. This shall include the regular water quality monitoring for sediments and hydrocarbons (monitoring the sediment concentrations in the receiving water) and the inspection of the pollution control facilities and method statements to ensure compliance with environmental quality standards specified in the relevant legislation.
11.4	C	Separate from the on-going and detailed monitoring carried out by the Contractor as part of the CEMP; the Site Environmental Manager (SEM) shall carry out the inspection/ monitoring regime described below on behalf of the Employer. The results will be stored in the SEM's Monitoring file and will be available for inspection/ audit by the Client, NPWS or IFI and OPW (where relevant). All inspections/ monitoring/ results will be recorded on standard forms. Inspections will include the following: • Inspect the Principal Control Measures outlined in the CEMP on a weekly basis. Report findings to the Contractor. • Inspect surface water treatment measures (ponds, tanks, mini-dams, sandbags, etc.) on a daily basis and obtain turbidity readings in the outlet receiving water. • Inspect all outfalls to watercourses and groundwater bodies on a daily basis and obtain turbidity readings. Where excavation, deposition, pumping out or concreting works are on-going in the vicinity obtain turbidity readings three times per day in the outlet receiving water. • Daily visual inspection of watercourses to which there is a discharge from the works and those where there is construction works in the vicinity. • Wheel wash facilities shall be inspected on a weekly basis. • Stockpiles shall be monitored on a daily basis while being filled or emptied and otherwise on a weekly basis. • Control measures for works at or near water bodies shall be inspected on a daily basis. • Concrete operations at or near watercourses shall be supervised and designated chute washing out facilities shall be inspected on a daily basis. • Site compounds and satellite compounds shall be inspected on a weekly basis. • The Contractor's monitoring results shall be audited by the SEM on a frequent basis (6 times per quarter at a minimum). • The investigatory level for turbidity is defined as a 10ntu difference between the ambient upstream watercourse level and the level downstream of the works. • Notwithstanding the stringent prevention measures listed above, in the unlikely event of an accidental release of sediment to a watercourse causing plumes or in the unlikely event of an exceedance of the turbidity investigatory levels arising, the following shall take place: o It shall be investigated immediately and thoroughly by the SEM and the Contractor. o The Incident Response Plan shall be activated.

Ref No.	Stage	Commitments
		○ The relevant NPWS, IFI and local authority staff will be notified immediately. ○ The Contractor will be required to take immediate action to detect source of release, corrective action to prevent release and to implement measures to ensure that such discharges do not re-occur. ○ Works if stopped shall not recommence until appropriate corrective measures to avoid any repetition are put in place. Such measures shall be agreed with the SEM following consultation with the NPWS and IFI. ○ Works and/ or discharges from the works shall not recommence until written consent is received from the SEM. Where the SEM considers that the risk of a sediment release is high for a particular construction activity, he/she shall inform the Contractor and request protective action to be taken before the construction activity commences. The SEM will be delegated powers under the contract sufficient for these instructions to be issued and implemented.
11.5	C/O	Water Quality Monitoring will be required prior to, during and post construction. Baseline water quality sampling shall commence a minimum of six months prior to construction and conclude a minimum of three months after full operation has commenced to assess potential residual impact. Turbidity monitoring will be included in sensitive watercourses downstream of the proposed road development crossings. The local authority will make recommendations regarding all the water quality parameters to be assessed, the sampling interval and locations. However, as a minimum requirement there will be monthly water quality analysis from a minimum of one upstream and one downstream sampling point at each construction water outfall and surface water crossing point. Furthermore, turbidity monitoring will be carried out on a daily basis. The Employer's Site Monitoring Team will review weekly monitoring reports to check water quality at receiving watercourses.
11.6	C	The following outlines the principal environmental commitments that will be prescribed for the construction phase in order to protect all catchment, watercourse and ecologically protected areas from direct and indirect impacts: • All constructional compound areas will be required to be located on dry land and set back from river and stream channels and out of floodplain areas. Floodplain areas include the Flood Risk Zones A and B and therefore all constructional compound areas need to be on lands above the 1000year return period flood level. • The storage of oils, fuel, chemicals, hydraulic fluids, etc. will not occur within 100m of the River Corrib or within the Floodplain Area as defined above. • Surface water flowing onto the construction area will be minimised through the provision of temporary berms, diversion channels and cut-off ditches, where appropriate. • Management of excess material stockpiles to prevent siltation of watercourse systems through runoff during rainstorms will be undertaken. This may involve allowing the establishment of vegetation on the exposed soil and the diversion of runoff water off these stockpiles to the construction settlement ponds and avoiding stockpiling of material in vicinity of sensitive watercourses. • Where construction works are carried out adjacent to turloughs, fens, stream and river channels and lakes, protection of such waterbodies

Ref No.	Stage	Commitments
		from silt load shall be carried out through use of reserved grassed buffer areas, timber fencing with silt fences or earthen berms. These measures will provide adequate treatment of constructional site runoff waters before reaching the watercourses. • Use of settlement ponds, silt traps and bunds and minimising construction activities within watercourses. Where pumping of water is to be carried out, filters will be used at intake points and discharge will be through a sediment trap or sedi-mat. • All watercourses that occur in areas of land that will be used for site compound/storage facilities will be fenced off at a minimum distance of 5m. In addition, measures will be implemented to ensure that silt laden or contaminated surface water runoff from the compound site does not discharge directly to the watercourse. Compounds shall not be constructed on lands designated as Flood Zone A or B in accordance with the OPW's The Planning System and Flood Risk Management Guidelines (November 2009). Site compounds will not be permitted in a European Sites (i.e. Lough Corrib cSAC). • Protection measures will be put in place to ensure that all hydrocarbons used during the construction phase are appropriately handled, stored and disposed of in accordance with the TII document "Guidelines for the crossing of watercourses during the construction of National Road Schemes". All chemical and fuel filling locations will be contained within bunded areas and set back a minimum of 10m from watercourses and floodplain areas. • Foul drainage from all site offices and construction facilities will be contained and disposed of in an appropriate manner to prevent pollution. • The construction discharge will be treated such that it will not reduce the environmental quality standard of the receiving watercourses. • Riparian vegetation along the identified sensitive watercourses will be fenced off to provide a buffer zone for its protection to a minimum distance of 5m except for proposed crossing points. • The use and management of concrete in or close to watercourses will be carefully controlled to avoid spillage. Where on-site batching is proposed, this activity will be carried out well away from watercourses. Washout from such mixing plants will be carried out only in a designated contained impermeable area. • All material deposition areas must be adequately bunded and compartmentalised such that the rainwater outflow from these facilities is adequately controlled and treated prior to reaching the receiving surface watercourses. The sediment control requirements are set out in the Sediment, Erosion and Pollution Control Construction Management Plan section of the CEMP (refer to **Appendix A.7.5**)
11.7	O	The flood relief mitigation measures to eliminate the flood risk of the proposed road development in the N83 Tuam Road and reduce the existing flood risk in this area are described as follows (refer also to **Figure 11.6** and **Table 11.41** of **Chapter 10, Hydrology**): • Prevent the upgraded portion of the N83 Tuam Road from spilling laterally northwards into the driveways of existing flood risk houses by: o Upgrade and provide effective road drainage network along the existing N83 Tuam Road for a length of 780m

Ref No.	Stage	Commitments
		○ Provide interceptor drain to capture rapid hill slope runoff from the southeast reaching the N83 Tuam Road ○ Provide for infiltration of this interceptor drain for the less severe rain storm events ○ Connect this interceptor drain to the proposed flood compensation storage • Compensate flood storage lost by providing compensation storage of 8,030m^3 in the form of an excavated rectangular engineered storage pond. The base elevation of 16m OD and a top design water level elevation of 17.5m OD • Connect this compensation storage to the remaining low-lying natural flood storage area located to the northwest of the proposed road development so that both storage areas are hydraulically linked via culverts. • Provide for permanent a pumping station and rising mains from the proposed compensation flood storage facility to discharge to the existing storm sewer with maximum pumping capacity of 250l/s
11.8	O	Refer also to **Table 11.41** in **Chapter 11, Hydrology** which outlines the required storage volumes required for the catchment for a range of return periods and durations events. The required flood storage, with an available pumping rate of 0.25cumec (i.e. 250l/s) from the engineered storage pond, is 20,700m^3 for the 100year event which is further increased to 24,800m^3 to include for 20% climate change The available storage provided in the engineered storage pond at a top water level of 17.5m OD is compensation storage of 8,030m^3 and the remaining (with proposed road development) natural storage provided of 18,470m^3 gives a total available flood storage of 26,500m^3, which is sufficient to achieve to meet and exceed the required storage.
11.9	O	To minimise the residual flood risk associated with the blockage of flood relief culverts and associated drainage assets there will be regular (monthly) inspection of N83 Flood Relief facilities be carried out to ensure that the system is in proper working order and performing as designed.

21.13 Biodiversity

Ref No.	Stage	Commitments
General		
8.1	C/O	All measures within this section will be implemented by the Contractor under the supervision of the supervision of the Project Ecologist (employed by the Employer) and/or the Ecological Clerk of Works (employed by the Contractor).
Designated Areas for Nature Conservation		
8.2	C/O	The environmental commitments required to ensure that the proposed road development will not result in a likely significant effect (i.e. adversely affect the integrity of) on the European sites within its ZoI (Lough Corrib cSAC, Lough Corrib SPA, Galway Bay Complex cSAC and Inner Galway Bay SPA) include measures to: • Minimise the habitat loss in Lough Corrib cSAC and to avoid loss of QI habitats within Lough Corrib cSAC (refer to habitats section below). • maintain the structural integrity of the rock mass supporting QI habitats in Lough Corrib cSAC during the construction of the proposed Lackagh Tunnel (and its western approach) (refer to soils and geology environmental commitment 9.9, 9.11 to 9.17). • avoid habitat degradation in Lough Corrib cSAC as a result of potential hydrogeological impacts during construction and operation (refer to Hydrogeology Section). • protect water quality in receiving watercourses during construction (refer to Hydrology Section). • control dust emissions during construction to prevent impacts on vegetation in Lough Corrib cSAC (refer to Air Quality and Climate Section). • avoid the introduction or spread of non-native invasive species to European sites during construction or operation. • avoid/reduce the disturbance/displacement effects of blasting on wintering birds using Ballindooley Lough (Refer to wintering birds section below). • avoid the proposed road development restricting Otter movement within the Bearna Stream catchment (Refer to Otter section below). • avoid mortality of the QI species of Lough Corrib cSAC. These include both measures to ensure that construction materials are not introduced into the River Corrib and to remove the risk of Otter being killed/injured due to collisions with road traffic (Refer to Otter section below).
8.3	C/O	The environmental commitments that are required to ensure that the proposed road development will not significantly affect Moycullen Bogs NHA are as follows: • Avoid/reduce the disturbance/displacement effects of blasting on wintering birds using Ballindooley Lough (Refer to wintering birds section below). • Measures to control dust emissions during construction to prevent impacts to vegetation/habitats within Moycullen Bogs NHA at Tonabrocky – see Air Quality and Climate section below. These include control measures such as spraying of exposed earthwork

Ref No.	Stage	Commitments
		activities and site haul roads during dry weather, wheel washes, control of site vehicle speeds, road sweeping and dust screens. • Measures to avoid the introduction or spread of non-native invasive species to Moycullen Bogs NHA during construction or operation. These are detailed in the Non-Native Invasive Species Management Plan which forms part of the CEMP in **Appendix A.7.5**. • Measures to control surface water runoff from the construction site to prevent an accidental pollution event affecting peatland habitats within Moycullen Bogs NHA at Tonabrocky – see Hydrology section below.
Habitats		
8.4	C	To minimise the loss of Annex I habitat, areas of these habitat types within the proposed development boundary but which are not required to construct the proposed road development will be retained and fenced off for the duration of construction. These are shown on **Figures 8.23.1** to **8.23.14**.
8.5	C	To minimise the loss of habitat associated with the proposed road development, there are also areas within the proposed development boundary which are included for mitigation planting where general construction works will not be undertaken. These are shown on **Figures 8.23.1** to **8.23.14.**
8.6	C	The minimum working area to facilitate the construction of the supporting structures associated with the proposed River Corrib Bridge will be used. This area will be clearly delineated and fenced off at the outset of works and maintained for the duration of the construction programme. No works for the construction of the River Corrib Bridge within Lough Corrib cSAC boundary will be undertaken outside of this zone.
8.7	C	Where possible, woodland, scrub, treelines and hedgerows which lie within, or along the boundary of the proposed road development, that are not directly impacted by the proposed road alignment or drainage will be retained. These areas will be protected for the duration of construction works and fenced off at an appropriate distance. Vegetation to be retained is shown on **Figures 8.23.1** to **8.23.14** and on **Figures 12.2.01** to **12.2.14** (landscape design).
8.8	C	Where possible, areas of river channel and bankside vegetation which lie within, or along the boundary of the proposed road development, that are not directly impacted by the proposed road alignment or drainage will be retained. These areas will be protected for the duration of construction works and fenced off at a distance of 5m from the stream/river bank.
8.9	C	The Petrifying spring feature present in Lackagh Quarry, which lies c.25m to the north of the mainline of the proposed road development at Ch. 11+400, will be retained and shotcrete[2] will not be used as part of the quarry face stabilisation measures at the spring site.
8.10	C	Any vegetation (including trees, hedgerows or scrub adjacent to, or within, the proposed development boundary) which is to be retained shall be afforded adequate protection during the construction phase in accordance with the Guidelines for the Protection and Preservation of Trees, Hedgerows and Scrub Prior to, During and Post Construction of National Road Schemes (National Roads Authority, 2006), as follows:

[2] A concrete product which is sprayed at high velocity into a rock face as a structural/stabilising component.

Ref No.	Stage	Commitments
		• All trees along the proposed development boundary that are to be retained, both within and adjacent to the proposed development boundary (where the root protection area of the tree extends into the proposed development boundary), will be fenced off at the outset of works and for the duration of construction to avoid structural damage to the trunk, branches or root systems of the trees. Temporary fencing will be erected at a sufficient distance from the tree so as to enclose the Root Protection Area (RPA) of the tree. The RPA will be defined based upon the recommendation of a qualified arborist. • Where fencing is not feasible due to insufficient space, protection for the tree/hedgerow will be afforded by wrapping hessian sacking (or suitable equivalent) around the trunk of the tree and strapping stout buffer timbers around it. • The area within the RPA will not be used for vehicle parking or the storage of materials (including soils, oils and chemicals). The storage of hazardous materials (e.g. hydrocarbons) or concrete washout areas will not be undertaken within 10m of any retained trees, hedgerows and treelines: o A qualified arborist shall assess the condition of, and advise on any repair works necessary to, any trees which are to be retained or that lie outside of the proposed development boundary but whose RPA is impacted by the works. Any remedial works required will be carried out by a qualified arboris. o A buffer zone of at least 5m will be maintained between construction works and retained hedgerows to ensure that the root protection areas are not damaged.
8.11	C	The mitigation strategy outlined in the Non-Native Invasive Species Management Plan included in the CEMP (see **Appendix A.7.5**) will be implemented sufficiently far in advance of the proposed construction works commencing so as to allow time to adequately control all target non-native invasive species populations within the Zone of Influence (ZoI) of the proposed road development, having regard to the specific timing/seasonal constraints that apply in relation to each individual species.
8.12	C	The implementation of the Non-Native Invasive Species Management Plan will include a pre-construction re-survey within the proposed development boundary. In accordance with the NRA guidance this survey will include accurate 1:5,000 scale mapping for the precise location of non-native invasive plant species. The pre-construction surveys will be undertaken by suitable experts with competence in identifying the species concerned.
8.13	C	In accordance with the *Guidelines on the Management of Noxious Weeds and Non-native Invasive Plant Species on National Roads* (National Roads Authority, 2010), where cut, pulled or mown noxious weed or non-native invasive plant species material arises, its disposal will not lead to a risk of further spread of the plants. Care will be taken near watercourses as water is a fast medium for the dispersal of plant fragments and seeds. Material that contains flower heads or seeds will be disposed of either by composting or burial at a depth of no less than 0.5m in the case of noxious weeds, or by incineration (at a licenced facility having regard to relevant legislation) or disposal to licensed landfill in the case of non-native invasive plant species.
8.14	C	The taproots of docks and roots of creeping thistle are not suitable for composting or shallow burial, requiring disposal to landfill, incineration

Ref No.	Stage	Commitments
		or burying at a depth of no less than 1.5m (practical only during the construction phase). Where burial is being used to dispose of Japanese knotweed, the material will be buried to a depth of 5m and overlain with a suitable geotextile membrane. All disposals will be carried out in accordance with the Waste Management Acts 1996 - 2011.
8.15	C	In relation to aquatic non-native invasive species all construction works, and any aquatic survey work that may be carried out (e.g. electrofishing), will comply with best practice biosecurity protocols for aquatic work – for example IFI's Biosecurity Protocol for Field Survey Work (IFI, 2010).
8.16	O	Areas of Annex I habitat within the proposed development boundary which are identified to be retained and fenced off during the construction of the proposed road development will also be avoided during the operational phase.
8.18	C/O	There will be no fencing within Annex I habitats that are located within Lough Corrib cSAC.
8.19	C/O	Areas of compensatory habitat will be created, managed and monitored as set out in the Compensatory Habitat Management Plan in **Appendix A.8.26**.
Otters		
8.20	C	A pre-construction check of all suitable Otter habitat will be required within 12 months of any constructions works commencing.
8.21	O	Otter passage facilities will be provided at all watercourses used by Otter (e.g. raised ledges within structures, or separate dry 600mm pipes installed adjacent to culverts). Mammal underpasses will be constructed in accordance with the *Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes* (National Roads Authority, 2008). The locations where Otter passage facilities will be provided are listed in **Table 8.36** of **Chapter 8, Biodiversity** and shown on **Figures 8.23.1** to **8.23.14**.
8.22	O	Mammal-resistant fencing will be installed in accordance with the specification outlined in *Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes* (National Roads Authority, 2008). The locations where mammal-resistant fencing is to be installed are shown on **Figures 8.23.1** to **8.23.14**.
8.23	O	Quarterly monitoring of the effectiveness of the environmental commitments will be undertaken in the first year after the completion of construction works.
Bats		
8.24	C	The Bat Derogation Licence included in **Appendix A.8.25** will be submitted to National Parks and Wildlife for their approval.
8.25	C	The environmental commitments set out in the Bat Derogation Licence included in **Appendix A.8.25** shall be adhered to by the Contractor.
8.26	O	The schedule of structures to provide bat passage and the function that they serve in terms of mitigating the potential barrier effect are as per **Table 8.35** of **Chapter 8, Biodiversity** and **Figures 8.23.1** to **8.23.14**.
8.27	O	The proposed planting design associated with the Castlegar Wildlife Overpass comprises of a double hedgerow in the middle section of the overpass (to mimic a 4m wide bóithrín). Each of the hedgerows will then diverge out to create a “mouth" at the entrance to the overpass on both sides of the proposed road development to funnel bats in to the centre of

Ref No.	Stage	Commitments
		the overpass. **Plate 2**, of **Chapter 8, Biodiversity**, shows the schematic design and location of the proposed overpass.
8.28	O	No lighting will be provided at or on any of the structures which have been designed to provide bat passage, with the exception of S06/01 where lighting will be provided to also allow for safe use by pedestrians. All of the bat underpasses (as well as artificial roosts) that are designed for Lesser horseshoe bats will have connecting woody vegetation features. Other bats species are not as reliant on hedgerows and woodland edges. Whilst there are many existing landscape features outside of the proposed development boundary, the bat mitigation strategy cannot rely on these in the long term as they may be subject to interventions by third parties. In effect, what will be created is a hedgerow corridor leading up to underpasses in the section of the proposed road development between Aughnacurra and Castlegar. This planting provides a guaranteed green corridor connecting up the underpasses/overpasses and will allow bats to adapt more easily to any future landscape scale losses of connecting habitat features. The hedgerow planting leading up to underpasses will be maintained and the growth of the hedgerow monitored for 5 years following completion and remediation works undertaken if deemed necessary.
8.29	C	As the baseline level of bat activity and roost occupancy can change over time, pre-construction monitoring will be carried out in advance of construction works commencing to ensure that the data against which the post-construction monitoring will be compared to is as up-to-date as possible (refer to Bat Derogation Licence included in **Appendix A.8.25**). Monitoring of the effectiveness of the bat mitigation and compensation measures will also be undertaken during and post-construction. Where the monitoring identifies issues with either the mitigation or compensation measures (e.g. light spill affecting usage), these will be remediated to ensure that those measures will achieve their aims with respect to mitigating or compensating for impacts on the local bat populations (refer to Bat Derogation Licence included in **Appendix A.8.25**).
Badgers		
8.30	C	A detailed summary of the environmental commitments as they relate to each of the Badger setts within the ZoI of the proposed road development is presented in **Appendix A.8.24** and summarised in **Table 8.36** of **Chapter 8, Biodiversity**. The non-interference zones (30m, 50m, and 150m) as they relate to each of the Badger setts within the ZoI of the proposed road development are illustrated on **Figures 8.23.1** to **8.23.14**. A pre-construction check of the activity status of all setts will be required within 12 months of any constructions works commencing within the ZoI of the setts discussed below.
8.31	C	In order to prevent any disturbance to Badger setts not directly affected by the proposed road development: • No heavy machinery shall be used within 30m of Badger setts at any time. • No works shall be undertaken within 50m of active setts during the breeding season. • Lighter machinery (generally wheeled vehicles) shall not be used within 20m of a sett entrance. • Neither blasting nor pile driving shall be undertaken within 150m of active setts during the breeding season (December to June inclusive)

Ref No.	Stage	Commitments
8.32	C	Prior to works commencing, a non-interference zone of 30m will be established around each of the Badger setts within the ZoI of the proposed road development, as shown on **Figures 8.23.1** to **8.23.14**. If the sett is active, non-interference zone will be extended to 50m during the breeding season (December to June inclusive). The fencing shall be as noted in **Chapter 7, Construction Activities** of a sufficient durability to maintain the exclusion zone throughout the construction period or, if required, until such time as the sett in question is excluded/removed.
8.33	C	Where setts require exclusion and removal, or temporary exclusion for the duration of the construction period, this will be undertaken in accordance with the methodology detailed in the Guidelines for the Treatment of Badgers during the Construction of National Road Schemes (National Roads Authority, 2006): • All Badger setts requiring exclusion and removal will require a monitoring period of at least five days to confirm activity status in advance of any construction works commencing. • If the sett is active, then it shall not be removed within the Badger breeding season (December to June inclusive). To exclude or remove an active Badger sett outside of this period, inactive entrances shall be soft and hard-blocked with one-way gates installed on active entrances. One-way gates will be tied open for three days before being set to exclude, and then monitored for a period of at least 21 days before the sett is deemed inactive and destroyed. If at any time during the monitoring period the sett becomes active, the exclusion process/programme must commence again from day 1 of the 21-day monitoring period. • For inactive setts, entrances will be soft-blocked (lightly blocked with vegetation and soil) and if all entrances remain undisturbed for a period of five days the sett should be destroyed immediately. This can be undertaken at any time of the year for inactive setts.
8.34	C	An artificial sett is required to mitigate for the loss of the main sett (S9), in conjunction with a subsidiary sett (S11), of the Lackagh Badger group. The requirements relating to the provision and design of the artificial sett are set out in **Appendix A.8.24**. The location of the artificial sett is shown on **Figures 8.23.1** to **8.23.14**.
8.35	C	Inaccessible areas (see **Figures 8.3.1** to **8.3.14**) will require a pre-works survey for badger setts in advance of site clearance. If a sett is uncovered, works must cease and a non-interference zone of 30m established; extended to 50m during the breeding season if set is active (December to June inclusive). Sett removal will follow the process outlined above.
8.36	O	To avoid badger road casualties, mammal passage facilities will be provided at strategic locations along the route of the proposed road development. Mammal underpasses will be constructed in accordance with the *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes* (National Roads Authority, 2006). Where engineering constraints conflict with the recommended locations at detailed design phase, mammal underpasses may be moved to the nearest most suitable location, but not more than c.250m away. The locations where Badger passage facilities will be provided are listed in **Table 8.36** and are shown on **Figures 8.23.1** to **8.23.14**.
8.37	O	A number of the mammal passage structures lie within the modelled light spill zone and artificial lighting may affect their usage by Badger: structures C07/04, C07/01(b) and C12/01. Screening will be provided to

Ref No.	Stage	Commitments
		ensure that the approaches and entrances to these structures are unaffected by light spill.
8.38	O	Mammal-resistant fencing will be required to guide badgers to the underpasses and will be installed in accordance with the specification outlined in *Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes* and will include badger proofing of emergency access roads and other similar access points, where located in areas where mammal-resistant fencing is to be installed. The locations where mammal-resistant fencing is to be installed are shown on **Figures 8.23.1** to **8.23.14**.
8.39	O	In accordance with the recommendations described in the *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes* (National Roads Authority, 2006), quarterly monitoring of the effectiveness of the environmental commitments will be undertaken in the first year after the completion of construction works.
Other mammal species (excluding bats)		
8.40	O	The schedule of structures to provide for mammal passage, as per **Table 8.36** and as shown on **Figures 8.23.1** to **8.23.14**, are required to ensure permeability for all other mammal species across the proposed road development during operation.
Invertebrates		
8.41	C	To avoid the destruction of Marsh fritillary eggs or the mortality of Marsh fritillary caterpillars, the following mitigation strategy will be implemented in relation to the site clearance works: • All areas within the proposed development boundary, which have been identified as suitable habitat to support the Marsh fritillary butterfly, will be subject to a pre-construction larval web survey. This will be undertaken during the mid-August to the end of September window immediately preceding site clearance works. • If larval webs are present, they will be translocated to another area of suitable habitat; either outside of the proposed development boundary or, if within, to an area of suitable habitat that will remain unaffected by construction works for the duration. • Once all larval webs have been removed from the affected areas, or if no larval webs were recorded, the vegetation will be immediately cleared or cut to ground level to render the area unsuitable for the species to recolonise. The vegetation shall be maintained in this state until such time as the topsoil is removed.
Birds		
8.42	C	Where feasible, vegetation (*e.g.* hedgerows, trees, scrub and grassland) will not be removed, between the 1 March and the 31 August, to avoid direct impacts on nesting birds. Where the construction programme does not allow this seasonal restriction to be observed, then these areas will be inspected by a suitably qualified ecologist for the presence of breeding birds prior to clearance. Areas found not to contain nests will be cleared within 3 days of the nest survey, otherwise repeat surveys will be required.
8.43	O	Planting of woodland, hedgerow and grassland habitats along the proposed road development as detailed in the landscape drawings (**Figures 12.2.01** to **12.2.14**) will provide compensatory habitat for some bird species.

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8.44	O	To further minimise the effects of breeding habitat loss, a total of 20 nest boxes will be erected by an ecologist in suitable locations away from the busy junctions/roadways. The siting and type of nest boxes will be decided on by an ecologist at locations where trees will be planted or retained along the proposed road development; as shown on **Figures 12.2.01** to **12.2.14**.
8.45	C	To minimise the effects of current levels of disturbance to the Barn owl nest site at Menlo Castle, and thereby reduce any cumulative effect that construction activities nearby may have, alternative nesting sites will be provided in the vicinity. Three Barn owl nest boxes will be erected across the area shown on **Figures 8.23.1** to **8.23.14** and will consist of either nest boxes erected on suitable trees or pole-mounted nest boxes. Preference will be given to erecting nest boxes on suitable trees, where possible. Tree mounted boxes will be erected at least 3m above ground level on a mature tree with few or no low branches to obscure the nest box. The selected tree shall be either isolated in a hedgerow or situated on a woodland edge with the access hole facing open ground. Pole-mounted nest boxes will be erected at a minimum height of 4.5m above ground. The nest box design (e.g. entrance hole size, floor area and depth from bottom of entrance hole to nest) shall be in accordance with the design requirements published by The Barn Owl Trust (http://www.barnowltrust.org.uk/). Nest boxes will be inspected annually for defects/damage and cleaned out/repaired as required to ensure waterproofness and the internal box depth.
8.46	O	Sections along the proposed road development will be planted with dense low growing scrub cover (e.g. blackthorn) to discourage Barn owls from foraging near the proposed road development. The planting will be of a density to minimise the lag time between planting and obtaining sufficient ground cover to deter foraging Barn owl.
8.47	O	In areas where there is a high probability that Barn owls may regularly attempt to cross the proposed road development (the section of embankment between Ch. 9+600 and Ch. 10+100), lines of closely spaced (approximately 2m centres) trees, greater than 3m in height, will be planted along the top of the embankments of the proposed road development; outside of the safety barrier and clear zone. The understorey will also be densely planted. This is to present a solid vegetated barrier to deflect Barn owl from these high-risk areas and/or force birds to fly over the proposed road development above the road traffic.
8.48	O	All mitigatory planting will be in place at the earliest feasible stage during construction to ensure that the mitigation is functioning as soon as possible. The locations where planting will be used to reduce the risk of Barn owl mortality from road traffic are shown on **Figures 8.23.1** to **8.23.14** and on the landscape drawings (**Figures 12.2.01** to **12.2.14**).
8.53	O	Following implementation of all environmental commitments for Barn Owls and completion of construction of the proposed road development, the following monitoring measures are proposed: • Surveys will be undertaken of roadside planting schemes at the end of years one and two with the objective of identifying and replacing failed plantings. • A road casualty survey to record barn owl mortalities along the route of the proposed development will be conducted once per week for a period of two years by a suitably qualified and experienced ornithologist. The proposed road development will be driven at a

Ref No.	Stage	Commitments
		steady pace in both directions so that all sections and both sides of the route will be covered. Where noted, all barn owl mortalities will be assigned to either the "breeding" season (March to July) or "non-breeding" season (August to January). Location details of the casualty will be recorded, including a 10-digit GPS co-ordinate, position on the route (central median, hard shoulder, or verge) and orientation (southbound, northbound, eastbound, and westbound). The age class of the bird will be determined and classed as either "pre-breeding" if first or second calendar year recovered before March, or "adult" if the bird is second calendar year recovered later than March or older. The adjacent habitat feature will be noted. This methodology is in line with that utilised for Barn Owl population status and the extent of road mortalities in relation to the Tralee Bypass (O'Clery et al., 2016). • Monitoring to determine activity and breeding status of all active sites within 5km of the proposed road development over two breeding seasons (March to July). This will be carried out concurrently with the road casualty survey, and will involve visits to known and potential nesting sites to determine brood size and breeding success. Where accessible, nests will be visited in order to ring owlets (subject to an appropriate licence from the NPWS). A report summarising the findings of the above monitoring will be submitted at the end of year two to the NPWS. The report may include further recommendations pending survey outcomes.
8.54	C	To minimise the potential for construction works near Lackagh Quarry to disturb the Peregrine falcon nest site, works from the Lackagh Tunnel to the N84 Headford Road Junction will commence prior to mid-February. The installation of rock bolts on the cliff faces in the vicinity of the nest site will be undertaken in a sensitive manner (as advised by a suitably experienced ecologist) so as to minimise any potential disturbance to the nest site during the breeding season, particularly if the nest site is occupied.
8.55	C	Construction noise will be kept to a minimum in accordance with BS 5228 (2009).
8.56	C	Blasting associated with the eastern approach to Lackagh Quarry (Ch. 11+800 to Ch. 12+100) will be carried out between the months of April to September (inclusive) to minimise the exposure of wintering birds at Ballindooley Lough to blasting-related disturbance.
8.57	C	Blasting associated with the cutting at Castlegar (Ch. 12+550 to Ch. 13+650) will take approximately nine months to complete, with an estimated five blast events per week. To minimise the exposure of wintering birds at Ballindooley Lough to blasting-related disturbance, all of those nine months must be in the April to September period (inclusive) within consecutive years.
Amphibians		
8.58	C	If works to clear any of the habitat features suitable to support amphibian species are to begin during the season where frogspawn or tadpoles may be present (February – mid-summer), or where breeding adult newts, their eggs or larvae may be present (mid-March – September), a pre-construction survey will be undertaken to determine whether breeding amphibians are present.
8.59	C	In the case of Common frog, any frog spawn, tadpoles, juvenile or adult frogs present will be captured removed from affected habitat by hand net

Ref No.	**Stage**	**Commitments**
		and translocated to the nearest area of available suitable habitat, beyond the ZoI of the proposed road development.
8.60	C	In the case of Smooth newt, individuals will be captured and removed from affected habitat either by hand net or by trapping and translocated to the nearest area of available suitable habitat, beyond the ZoI of the proposed road development. If used, the type and design of traps shall be approved by the NPWS. This is a standard and proven method of catching and translocating Smooth nest.
8.61	C	If the size or depth of the habitat feature is such that it cannot be determined whether all amphibians have been captured, it will be drained under the supervision of a suitably experienced ecologist to confirm that no amphibian species remain before it is destroyed or infilled. Any mechanical pumps used to drain the habitat feature will have a screen fitted, and be sited, such that no amphibian species can be sucked into the pump mechanism.
8.62	C	Any capture and translocation works shall be undertaken immediately in advance of site clearance/construction works commencing.
8.63	O	The schedule of structures to provide for mammal passage, as per **Table 8.36** and as shown on **Figures 8.23.1** to **8.23.14**, are required to ensure permeability for amphibian species across the proposed road development during operation.
Reptiles		
8.64	C	In order to minimise the risk of site clearance and construction works disturbing, or causing the mortality of, Common lizard the following schedule of site clearance works will be followed in the areas highlighted on **Figures 8.10.1** to **8.10.8**, where the presence of Common lizard has been confirmed: • grass, scrub or heath vegetation will be removed during the winter period, where possible, avoiding potential Common lizard hibernacula sites (dry sites which provide frost-free conditions e.g. stone walls, underground small mammal burrows, piles of dead wood or rubble). • where this is not possible and clearance will be undertaken during the active season (March through to September, inclusive), vegetation will be cut first to approximately 15cm, and then to the ground, under supervision of an ecologist. This will allow the opportunity for lizards to be displaced by the disturbance and leave the affected area. • stone walls (or other potential hibernacula sites) will be removed during the active season (March through to September, inclusive) under the supervision of an ecologist, when they are less likely to be in use by torpid lizards.
8.65	O	The schedule of structures to provide for mammal passage, as per **Table 8.36** and as shown on **Figures 8.23.1** to **8.23.14**, are required to ensure permeability for the Common lizard across the proposed road development during operation.
Fish		
8.66	C	To minimise the effects of habitat loss on fish species, all sections of river/stream channel within the proposed development boundary, but not within the footprint of the proposed road development and associated infrastructure, will be protected from site clearance and construction works. Rivers/streams will be fenced off at a minimum distance of 5m

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		from the river bank and within this zone the natural riparian vegetation will be retained.
8.67	C	To minimise the potential effects of construction works on fish species the following environmental commitments will be implemented: • No instream works will be carried out between the months of October and June (inclusive) to avoid the most sensitive time for fish species and fish species movements. • Design of new sections of river channel shall be in accordance with the principles outlined in Channels & Challenges. Enhancing Salmonid Rivers. (O'Grady, 2006). • Immediately prior to rivers/streams being diverted into a newly constructed river channel or culvert, they will be electrofished (if required) to capture and transfer fish from the original channel to the new one. Once the watercourse has been diverted this will be followed by a manual search of the original watercourse to transfer any remaining fish to the new river/stream channel). • Any water abstraction points required for dust suppression will be agreed with IFI and the suction head shall be screened to ensure that fish are removed during the abstraction process.
8.68	C	All temporary crossing structures used to cross watercourses during construction will be designed in accordance with the *Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters* (IFI, 2016) and *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes* (National Roads Authority, 2005) to maintain fish and macroinvertebrate passage, and to prevent sedimentation and erosion.