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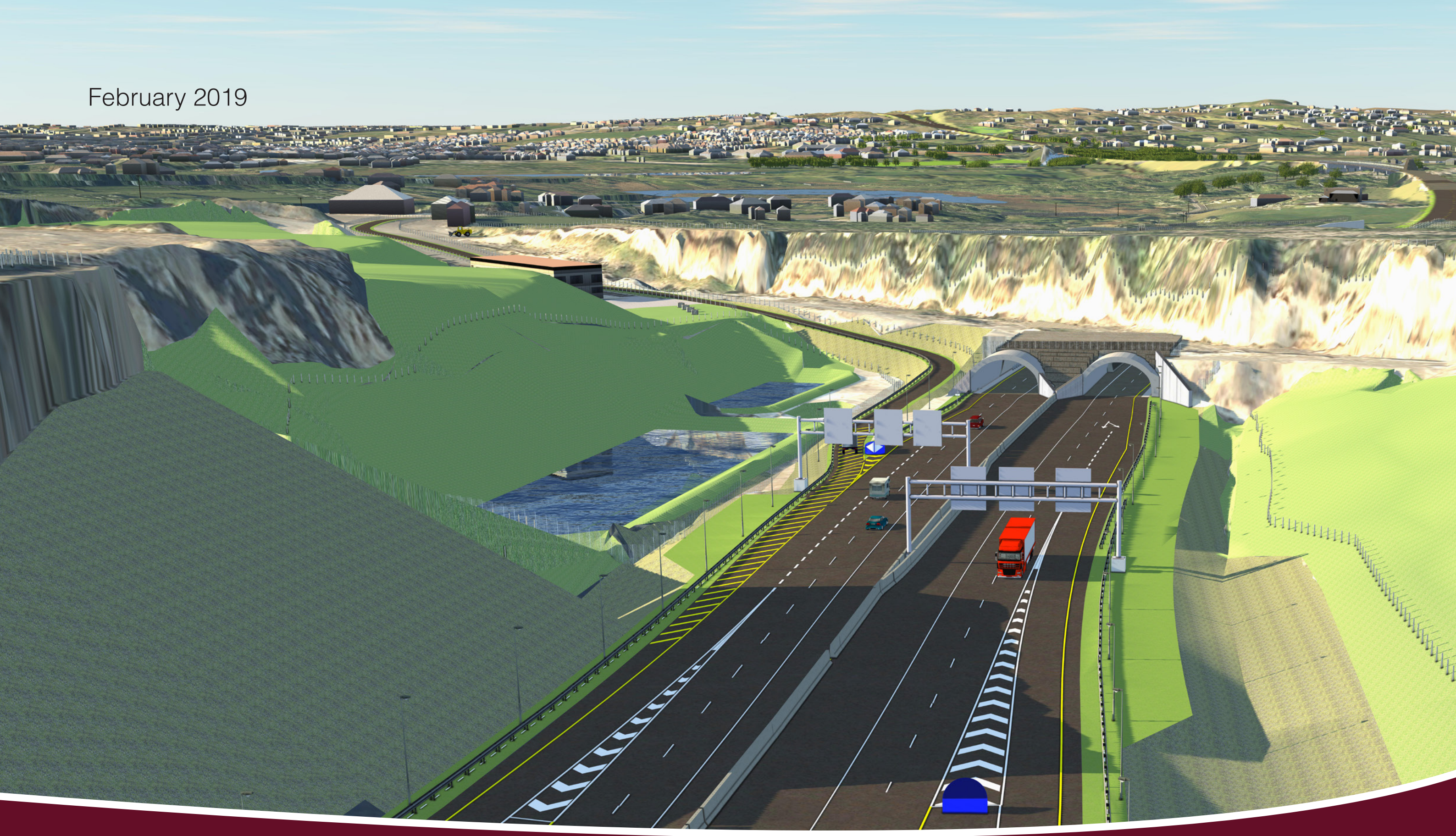

Galway City Transport Project

N6 Galway City Ring Road Design Report

Volume 1 | Main Report

ARUP

Galway County Council

N6 Galway City Ring Road Project

Design Report

GCOB 4.04.017

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1 Introduction

1.1 Project Introduction and Description

1.1.1 N6 Galway City Ring Road

Galway County Council is progressing the proposed N6 Galway City Ring Road (GCRR) through the statutory process on behalf of itself and Galway City Council under a Section 85 Agreement[1]. For ease of reference, the N6 GCRR and all of its associated development works is referred to throughout this report and the project documentation as the proposed road development.

The proposed road development comprises the construction of approximately 6km of single carriageway from the western side of Bearna as far as Ballymoneen Road and approximately 12km of dual carriageway from Ballymoneen Road to the existing N6 at Coolagh, Briarhill. There are associated link roads, side roads, access roads, junctions and structures. A full description of the proposed road development is provided in **Chapter 2, Description of Proposed Road Development** and in subsequent chapters of this design report. A plan layout is presented on Drawings **GCOB-000-D-000** to **015** in **Volume 2**.

This chapter outlines the background to the proposed road development and describes the methodology used to prepare this design report.

1.2 Background to the Scheme

1.2.1 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. Approval for this scheme was unsuccessful. 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.

1.2.2 Project Objective

The principal objective of the new project is to deliver the additional crossing of the River Corrib and the new link road as proposed by the Galway Transport Strategy. More detail on the specific objectives on the N6 GCRR are given in **Chapter 2, Description of Proposed Road Development** of this report.

[1] An agreement has been entered into under the provisions of Section 85 of the Local Government Act 2001 and Section 14 of the Roads Act 1993, as amended, whereby Galway County Council agrees with Galway City Council exercising and performing all of the statutory powers and functions of the respective County Councils to complete to Phase 4 (the Design and Land Acquisition Procedure) of N6 Galway City Ring Road.

1.2.3 Development of the Transport Solution for Galway

Galway County Council, Galway City Council, Transport Infrastructure Ireland[2] (formerly known as National Roads Authority) and the National Transport Authority collaborated in developing a transport vision for Galway where all elements of transport are working together to achieve an integrated sustainable solution.

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 Route Selection Report for the N6 GCTP concluded with the recommendation of the preferred route corridor for additional road infrastructure, with the extent of this road infrastructure in this corridor being determined as part of the wider transport strategy for Galway. 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 Design Report.

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 the development of this strategy to inform 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.

[2] 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.

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.

The N6 GCRR is proposed as part of the GTS and its purpose is to deliver the necessary capacity and support the delivery of sustainable transport measures, particularly within the city centre.

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.

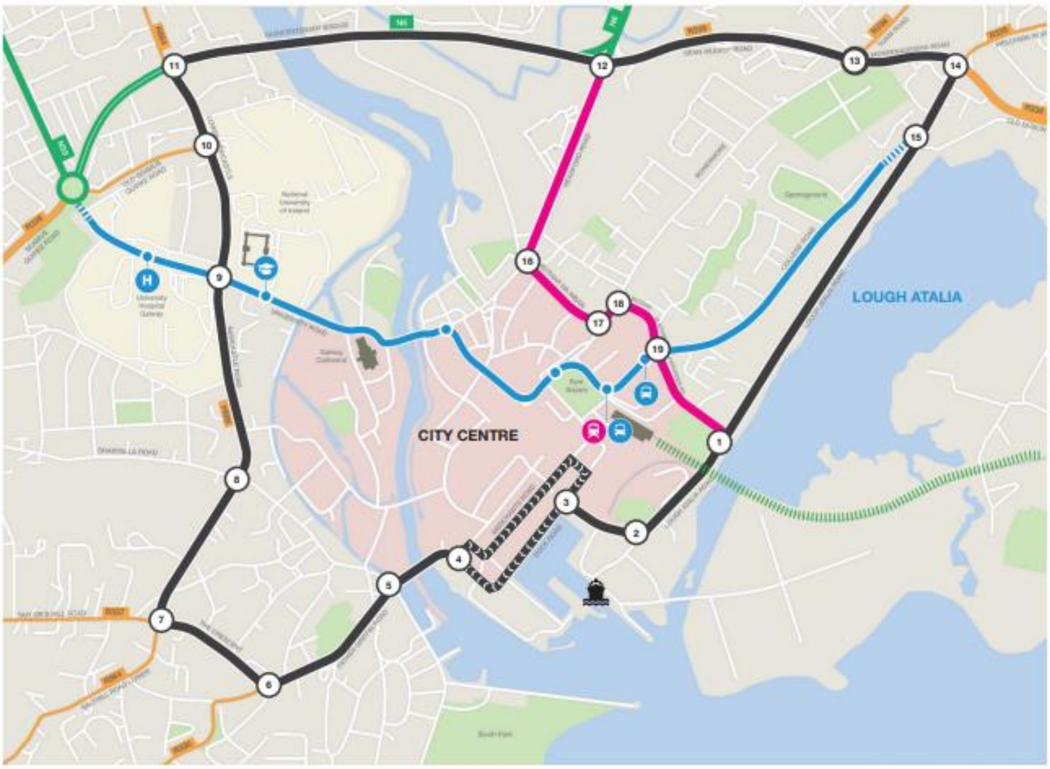
The GTS aims to remove non-essential motorised traffic from the core city centre area (i.e. traffic travelling through the city centre whose origin and destination lie outside the city centre).

This will be achieved using a combination of routes around the city centre (termed the ‘City Centre Access Network’ shown in black in **Figure 1.1**), and will prioritise other modes within the core city centre area via the ‘Cross-City Link’ (shown in blue on **Figure 1.1**), 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.

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 also 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.

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 Design Report, is a necessary component of the Galway Transport Strategy in order to deliver the transport solution for Galway.

Figure 1.1: City Centre Access Network



Further details on the GTS are available on www.galwaycity.ie/galway-transport-strategy/

1.3 Scope of the Report

This report presents the design basis of the proposed road development. This report has been prepared in accordance with the requirements of Transport Infrastructure Ireland (TII) 2010 Project Management Guidelines (PMG). They guide scheme development and detail a framework for the phased approach to the development, management and delivery of major national road schemes in Ireland. This report documents the work undertaken in Phases 1 to 3 in developing a design to current standards which meets the project objectives.

The guidelines are divided into seven phases namely:

- Phase 1 *Scheme Concept & Feasibility Studies*
- Phase 2 *Route Selection*
- Phase 3 *Design*
- Phase 4 *EIA & The Statutory Processes*
- Phase 5 *Advance Works & Construction Documents Preparation, Tender & Award*
- Phase 6 *Construction & Implementation, and*
- Phase 7 *Handover, Review & Closeout*

The design of the proposed road development commenced at Phase 1 *Scheme Concept & Feasibility Studies* in January 2014. The conclusion of Phase 1, *Scheme Concept & Feasibility Studies*, was that there was a strong justification for advancing a scheme which included a combination of both public transport and road-based solutions. A public transport only solution was also considered but was deemed incapable of delivering a solution in isolation.

Phase 2 investigated various alternatives, a summary of which is provided in **Section 1.3.1**. The final Route Selection Report was published in March 2016. This report is available on the project website at:

http://www.n6galwaycity.ie/phase-2/route-selection-report/

The design of the proposed road development was developed during *Phase 3 – Design* to a stage where sufficient levels of detail existed to establish landtake requirements and to progress the proposed road development through the statutory processes. This design report outlines the methodology and design principles adopted in the design of the proposed road development. The design report is a key deliverable of Phase 3. During Design development designers risk assessments were undertaken, details of these are included in **Appendix A.3.4**.

The objective of Phase 4 *EIA REPORT/EAR and The Statutory Processes* is to complete an environmental assessment of the design developed in Phase 3, identify the potential impacts of the proposed road development on the receiving environment and establish mitigation measures required. Legal documentation for land acquisition is also completed as part of this phase, in addition to the statutory processes necessary to confirm that the proposed road development is in accordance with planning and environmental legislative and procedural requirements.

1.3.1 Summary of Route Selection Process

A suitable study area within which key constraints were identified, alternatives examined, and feasible solutions developed was identified during Phase 2 – *Route Selection* between 2014 and 2015. The analysis undertaken during Phase 2 showed that the solution to the existing problems in Galway required an overall transportation solution as opposed to a typical bypass at a distance from the city. Therefore, from Phase 2 onwards, the focus was on trying to find a transportation solution.

Collectively an upgrade of the existing infrastructure, an 'on-line' option, and numerous 'green field' options, as well as an assessment of improvements to public transport, were considered during Phase 2, both in isolation and in combination with each other.

The options which were considered are outlined below:

- "Do-Nothing": This option is the Base Year model with growth factors applied to the existing population and traffic data up to the year of opening
- "Do-Minimum": This option includes road and non-road schemes, including smart mobility measures, which have been committed or are likely to proceed before the year of opening
- "Do-Something Public Transport": This option was based on measures, options, and schemes identified by the existing *Galway Public Transport Feasibility Study* of 2010 for Galway City Council, including smart mobility measures
- Lough Corrib Route Options
- Coastal Route Options
- Tunnel Over Project Extents
- Upgrade Existing Road Alternative (On-line): The first road option developed was the on-line upgrade of the existing road infrastructure and utilised the existing N6 and the R338
- Build New Road Alternative (Off-line): This option included off-line route options connecting the R336 in the west to the N6 in the east

An assessment of the following options discounted them from further consideration as they were deemed not to meet the project objectives:

- 'Do-Nothing' as it would not offer a positive economic benefit as it would not serve to reduce the existing congestion and would result in a decrease in efficiency of the transportation infrastructure over time
- 'Do-Minimum' as it would not offer a positive economic benefit as it would not serve to reduce the existing congestion and would result in a decrease in efficiency of the transportation infrastructure over time
- 'Do-Something Public Transport' as it has a negative impact on congestion and only marginally increases the modal share of public transport and therefore fails to meet the project objectives when implemented in isolation
- Lough Corrib Route Option at it would not reduce journey times on key routes and would not provide a cost-effective project. It would have a significant impact on designated Natura 2000 sites and may not support the development of critical mass regional population centres as it will not support the development of Galway City as a Gateway
- Coastal Route Options at it would not reduce journey times on key routes, it would have a significant impact on designated Natura 2000 sites and would not be in keeping with the existing landscape

- Tunnel over project extents as it would not provide a connection to some or all of the national roads leading into the city, it would not show an improvement on journey times and journey time reliability plus the demand does not justify the very significant cost of such a tunnel

Route Options carried forward for further assessment comprised on-line options which include an upgrade of the existing infrastructure, partial on-line/off-line options and total new construction off-line:

- The on-line Route Option utilises the existing Regional and National road corridors to connect from Bearna to the M6 / N6 on the east side of Galway at Ardaun. It also requires a section of new road construction to connect from the R336 Bearna Road to the western end of the Western Distributor Road. It utilises the Western Distributor Road to connect to the R338 which then connects to the N6. This is known as the Red Route Option
- The Off-line Route Options comprise new road alignment from the R336 to the west of Bearna to the M6 / N6 on the east side of Galway at Ardaun. These are known as the Green Route Option, the Blue Route Option and the Pink Route Option
- The partial On-line / Off-line Route Options utilise a section of new road alignment on the west of the River Corrib, and utilise a portion of the existing N6 road corridor on the east of the River Corrib. These are known as the Orange Route Option and the Yellow Route Option

The former scheme, the N6 Galway City Outer Bypass (GCOB), was included in the assessment of alternatives. In addition, the Cyan Route was developed as 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. Both the original 2006 GCOB alternative and the Cyan Route Option were discounted from further consideration as there are other alternatives which better meet the project objectives in terms of capturing existing travel demand and which do not impact on the integrity of the Lough Corrib cSAC.

A further alternative known as the ‘Green - Blue Switch Route Option’ provided an alternative route option which included the Green Route Option from the R336 to and including, the River Corrib crossing point. It then connected with the Blue Route Option on the east side of the River Corrib to the east of Menlo Castle, and followed the path of the Blue Route Option to the N6. This was discounted from further consideration as there are other alternatives which better meet the project objectives which do not impact on the integrity of the Lough Corrib cSAC.

Of the above alternatives, the Red, Orange, Yellow, Blue, Pink, and Green Route Options were taken forward for further analysis and assessment. The conclusion of this analysis was that additional road infrastructure was required, which includes an additional River Corrib bridge crossing.

The systematic assessment of these options was undertaken which led to the selection of the Emerging Preferred Route Corridor for the N6 Galway City Ring

Road (GCRR) which comprised of sections of the various route options and it became the road component of the N6 Galway City Transport Project.

1.4 Summary of Peer Review Process

Throughout the design process a number of design working papers were submitted to the TII peer review team prior to attending the Phase 3 Peer Review on 24 November 2016 in the N6 Project Office, Ballybrit, Galway. A copy of the Peer Review Record carried out is provided in **Appendix A.2.3**. A number of design changes were incorporated into the design following the peer review process, these are presented as part of the design detailed in this design report.

Following the development of the design of the proposed road development a detailed Project Appraisal Audit was carried out on behalf of the Strategic & Transport Planning Section in TII. The deliverables audited included, the Project Brief, Traffic Modelling Report, Cost Benefit Analysis Report, Project Appraisal Balance Sheet and the Business Case. The record of the Project Appraisal Audit is contained in **Appendix A.2.4**.

The Department of Public Expenditure and Reform's (DPER) Public Spending Code requires that Government Department and Agencies undertake cost benefit analysis or economic appraisal on all expenditure proposals with an estimated value in excess of €20 million. Departments are further required to submit appraisals to the DPER for technical review. The technical review was carried out by the Irish Government Economic & Evaluation Service Unit (IGEES) in DEPR and the Review report is contained in **Appendix A.2.5**.

1.5 Design Report Status

Upon completion of the Design Report, an update to the OS electronic mapping was obtained from OSI in early September 2018. A cross-check was completed by the environmental assessment team to ensure that their assessment took cognisance of any impacts on new housing/buildings. Such updates to the OS mapping did not fundamentally change the design, and therefore, the entire suite of drawings in this Design Report were not updated. The accommodation works drawings **GCOB-D-2700-101** to **115** were updated to include this updated background mapping.

The design of the proposed road development may be subject to refinement and enhancement as the proposed road development is progressed through the subsequent phases of development. The design for Phase 5 and Phase 6 shall be designed in accordance with TII, DTTAS, NTA and other relevant design standards current at the time of undertaking. Design development during subsequent phases of development will seek to develop this design in a manner that has no material change on the proposed road development or its environmental effects as outlined in the Environmental Impact Assessment (EIA) Report. Stringent contractual requirements and close supervision will ensure that the detailed design will be of the required quality and that through the construction process this design will be translated into the final product.

2 Description of Proposed Road Development

2.1 Overview

The proposed road development is located in Galway as shown on **Figure 2.1** with the proposed plan layout shown on Drawings **GCOB-000-D-000** to **015** and the plan and profile of mainline and side roads shown on Drawings **GCOB-100-D-100** to **111** and **GCOB-100-D-200** to **221** respectively. These drawings are included in **Volume 2**.

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.

East of the River Corrib the proposed road development continues east on embankment toward the Menlough Viaduct. It crosses over Bóthar Nua in the townland of Menlough and remains on viaduct section, Menlough Viaduct, towards Seanbóthar before entering a section of cut preceding Lackagh Tunnel immediately west of Lackagh Quarry, and exits the tunnel in the quarry. The proposed road development continues east with a grade separated junction located at the N84 Headford Road Junction at Ballinfoyle. The road continues east through the townland of Castlegar to the grade separated junction at the N83 Tuam Road. 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.

The proposed road development then continues eastwards entering the Galway Racecourse Tunnel at Ballybrit to the north of the racetrack. On emerging from the tunnel, the proposed road development continues south, crossing over the Briarhill Business Park Road and 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.

Further detailed descriptions and technical information of the proposed road development are provided in the subsequent chapters of this report.

Figure 2.1: Proposed N6 Galway City Ring Road

The remainder of this chapter outlines the Project Context (**Section 2.2**), Project Objectives (**Section 2.3**), and Traffic Modelling (**Section 2.4**).

2.2 Project Context

2.2.1 Identification of Need

The overriding need for the proposed road development 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 competitiveness by reducing transport costs.

The need to deliver the proposed road development is supported in terms of policy from European to local level. 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 summarised below in **Section 2.2.2**, whilst full detail on these policies are outlined in the Project Brief in **Appendix A.2.2**.

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 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 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 proposed road development is a component, as this congestion is experienced by all travellers using various transport modes.

The overall need for the provision of the proposed road development is as follows:

- 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 proposed road development 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 proposed road development, 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 proposed road development 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 proposed road development 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

2.2.2 Policy Background

2.2.2.1 European Policy 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.

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 forms part of the TEN-T comprehensive road network in Ireland[1], as can be seen in **Figure 2.2** below.

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

Figure 2.2: 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 below (ref: 2.3):

- 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
- Improve accessibility of the Galway urban area to its main markets
- Integration of Galway City and its environs (including western parts of Galway County) into the national economic development agenda
- 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.

2.2.2.2 National Policy Context

2.2.2.2.1 Building on Recovery: Infrastructure and Capital Investment 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 (NPF) to ensure the money is spent in accordance with an overall plan.

2.2.2.2.2 Smarter Travel, A Sustainable Transport Future, 2009

"*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 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 below.

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 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 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 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. Detail for the individual actions and their compliance is provided in Table 2.1 Chapter 2, Planning and Policy of the Environmental Impact Assessment Report.

2.2.2.2.3 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.

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.

2.2.2.2.4 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 National Planning Framework (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 National Spatial Strategy (NSS) provided the policy framework for all regional and local plans, including the Regional Planning Guidelines for the West Region, 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.

The NSS emphasised significant growth improvement in the regions and more particularly in the nine gateway cities and nine hub towns. Balanced regional development is defined as *"developing the full potential of each area to contribute to the optimal performance of the state as a whole – economically, socially and environmentally"*.

The National Spatial Strategy (NSS) identified the main cities and surrounding hinterlands of Cork, Galway, Limerick and Waterford as having the potential, when combined, of counterbalancing the strong development in the eastern regions around Dublin.

The National Spatial Strategy is replaced by the National Planning Framework (NPF), as prepared by the Department of Housing, Planning and Local Government.

2.2.2.2.5 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). 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.

2.2.2.3 Regional Policy Context

2.2.2.3.1 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*.

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.

2.2.2.3.2 New Regional Assemblies

Three new Regional Assemblies came into being on 1 January 2015, namely the Northern & Western, 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.

As set out above, at the same time as the publication of the draft National Planning Framework, three Regional Assemblies of all 31 local authorities across the country have begun 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 has published an Issues Paper for public consultation (submissions to be 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 Draft 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 centres 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.

2.2.2.4 Local Policy Context

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

Both Councils are committed to intensifying public transport delivery and usage to deliver growth and improve quality of life in their county. Both the City and County Development Plans support the Galway Transport Strategy which 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. The proposed road development is part of this Transport Strategy.

2.2.2.4.1 Galway Transport Strategy (GTS) 2016

Galway City Council and Galway County Council, in partnership with the National Transport Authority, 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 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.

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.

2.2.2.4.2 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, 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 supported and informed by the Galway Transport Strategy (GTS) set out 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 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 proposed road development 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 proposed road development
- Policy 3.10 Specific Objectives emphasises the principles and objectives of the GTS, with specific reference to the proposed road development
- Economic Activities (Chapter 5) Strategy which incorporates specific reference to the delivery of the GTS and the proposed road development, 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 proposed road development"
- 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 road development, 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 proposed road development 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.

2.2.2.4.3 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. This 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 Draft 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*" (Draft 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 8,000 people and also function as a mixed use business and retail district.

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.

2.2.2.4.4 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.

2.2.2.4.5 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 Proposed 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 Proposed Variation, refers to Chapter 5 of the Galway County Development Plan, as set out in **Section 2.2.2.4.4** 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.

2.2.2.4.6 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 May 2018.

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.

2.2.2.4.7 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.

2.2.2.5 Policy 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 the 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 the 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 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. The release of the 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.

2.3 Project Objectives

2.3.1 Overview

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 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 summarised in this chapter. 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.

2.3.2 Economic Objectives

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

2.3.3 Safety Objectives

The 'Safety' Objectives for 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

2.3.4 Environmental Objectives

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

2.3.5 Accessibility and Social Inclusion Objectives

The 'Accessibility and Social Inclusion' Objectives for 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

2.3.6 Integration

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.

2.3.7 Physical Activity

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

2.4 Traffic Modelling Report

2.4.1 Introduction

This section provides a summary of the Traffic Modelling Report (TMR) of the proposed road development. The TMR is included in **Appendix A.2.1**.

2.4.1.1 Key Assessment Terminology

Presented below are some of the key terms that are used throughout this section 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. It is also used in the assessment of impacts of noise and vibration on the receiving environment
- **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 8 to 9am in the morning when commuters are travelling to work and school with a corresponding peak in the evening, usually from 5 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 queuing length 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)

2.4.2 Transportation Assessment Methodology

2.4.2.1 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' [2]) and without the proposed road development ('Do-Minimum'[3]) 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

2.4.2.2 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.2.1**), 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 Census 2011 data to understand existing levels of travel demand and traffic patterns on the 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 Region Model (WRM), centred on Galway, which was used as part of this traffic assessment.

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2 'Do-Something' relates to a situation where the proposed road development is approved and proceeds as expected.
3 'Do-Minimum' relates to a situation where the proposed road development does not proceed.

2.4.2.3 Traffic Modelling

2.4.2.3.1 Traffic Model Development

Western Regional Model (WRM)

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).

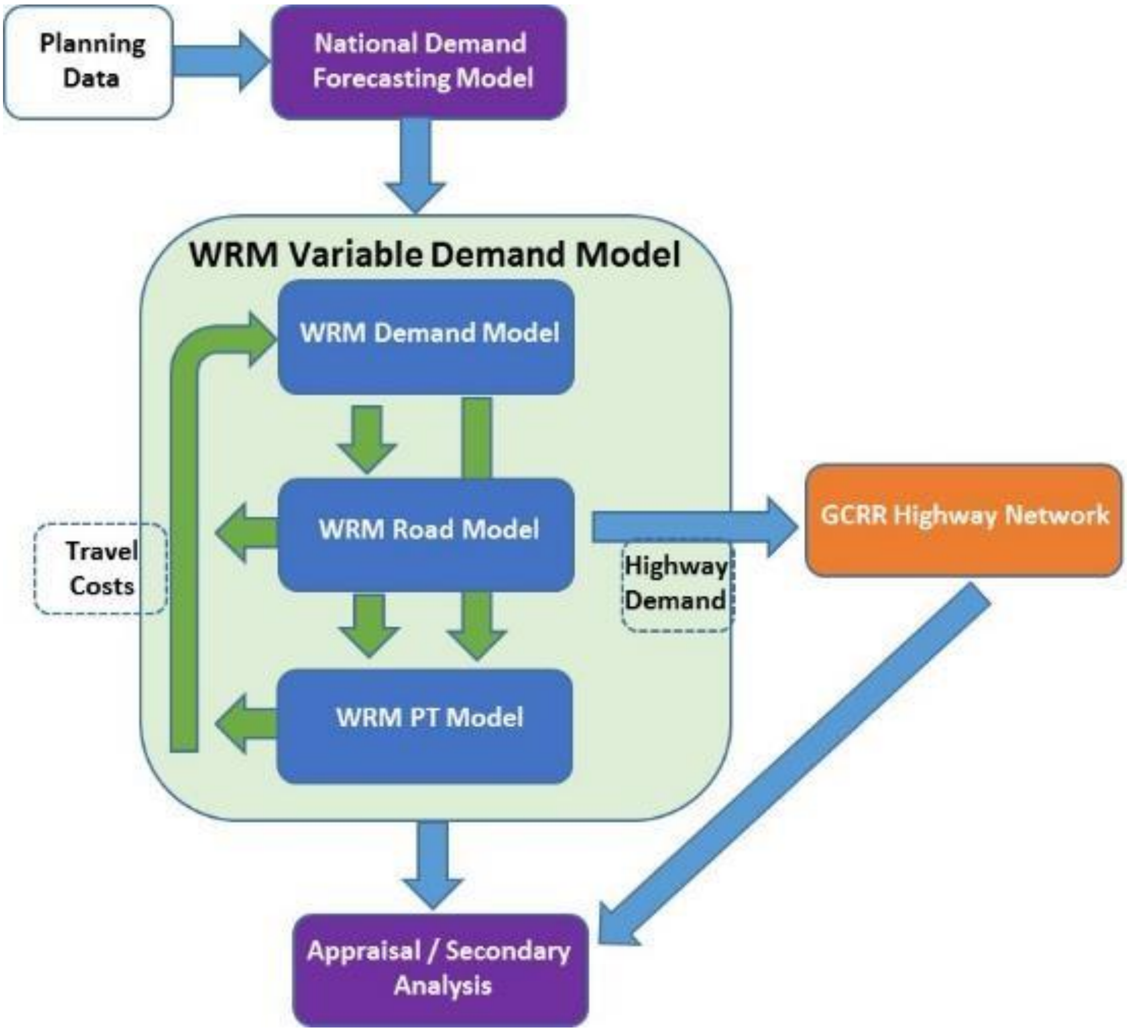
N6 Galway City Ring Road Model

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.2.1**).

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 **Figure 2.3** below.

Figure 2.3: 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)

2.4.2.3.2 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.2.1** which contains a full description of the model development and traffic impact analysis process.

2.4.3 Receiving Environment

2.4.3.1 Existing Road Network

The existing road network is shown on **Figure 2.4**. 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 2.4.3.5** 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.

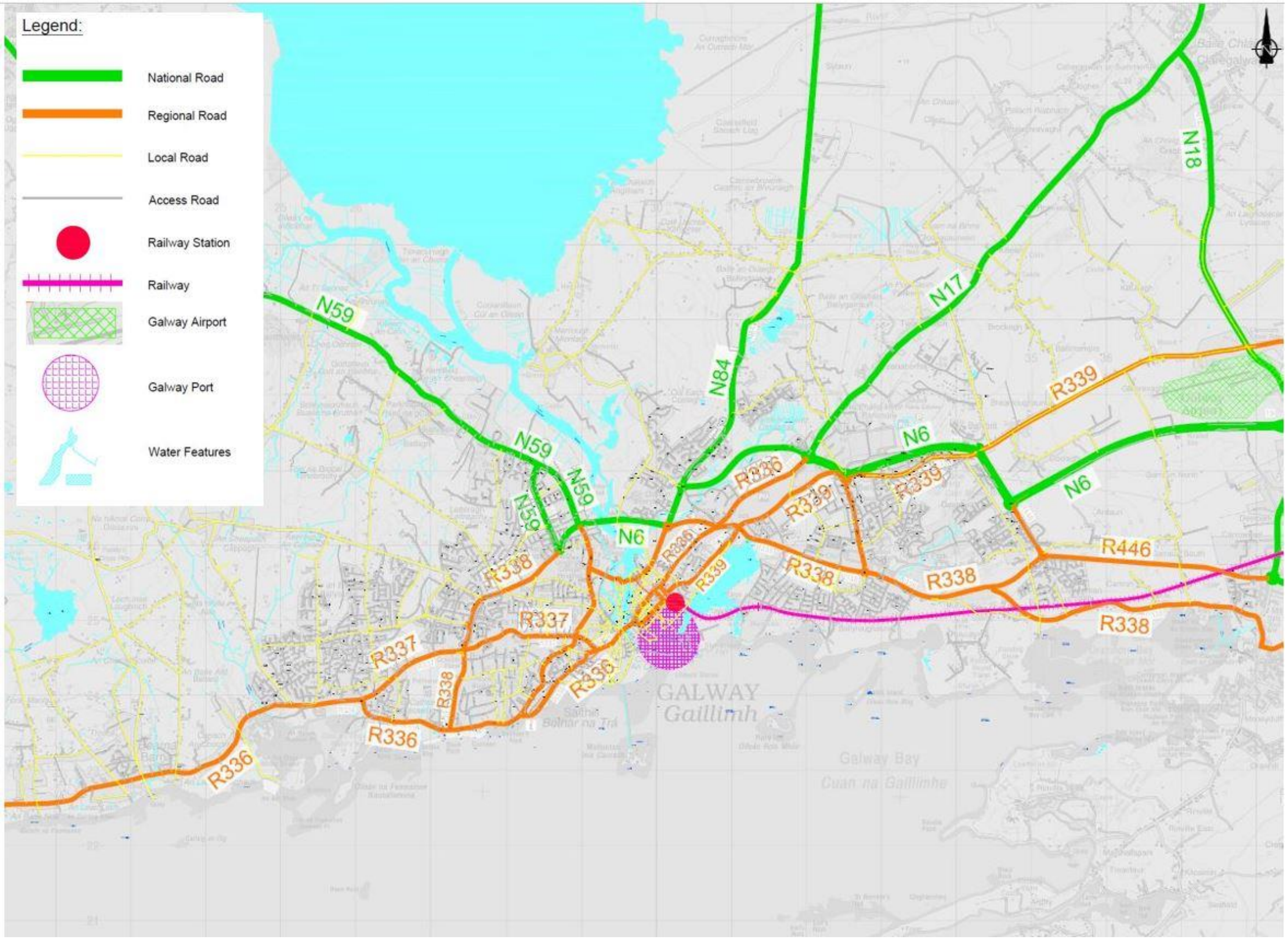
The existing N6 continues as a dual carriageway to the at-grade signalised junction at the Ballybane Junction and onto the N83 Tuam Road, again a signalised junction. This particular junction experiences delays at peak hours due to the traffic volumes on the N83 Tuam Road being equivalent to the volumes 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 2.4.3.5** 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 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.

Figure 2.4: Existing Road Network



2.4.3.2 Existing Travel Patterns

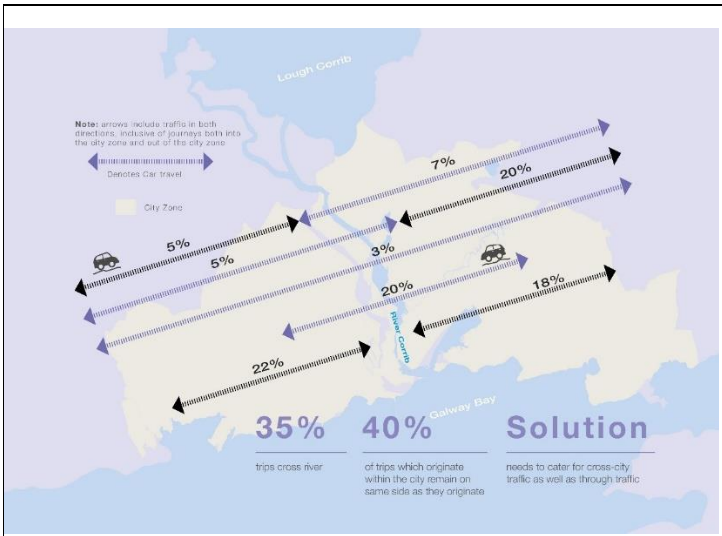
An analysis of desire lines for travel in Galway City and its environs has been undertaken using the West Regional Model to gain an understanding of travel patterns in the proposed road development study area. This has been developed using the extensive information on trip origins and destinations incorporated 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.

Figure 2.5 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.

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.

Figure 2.5: Travel Patterns 2012 Base Year Morning Peak Hour



Note: *arrows include traffic in both directions, inclusive of trips both into the zone and out of the zone*

2.4.3.3 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 2.1**.

Table 2.1: 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.

2.4.3.4 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 **Figure 2.6**. 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.

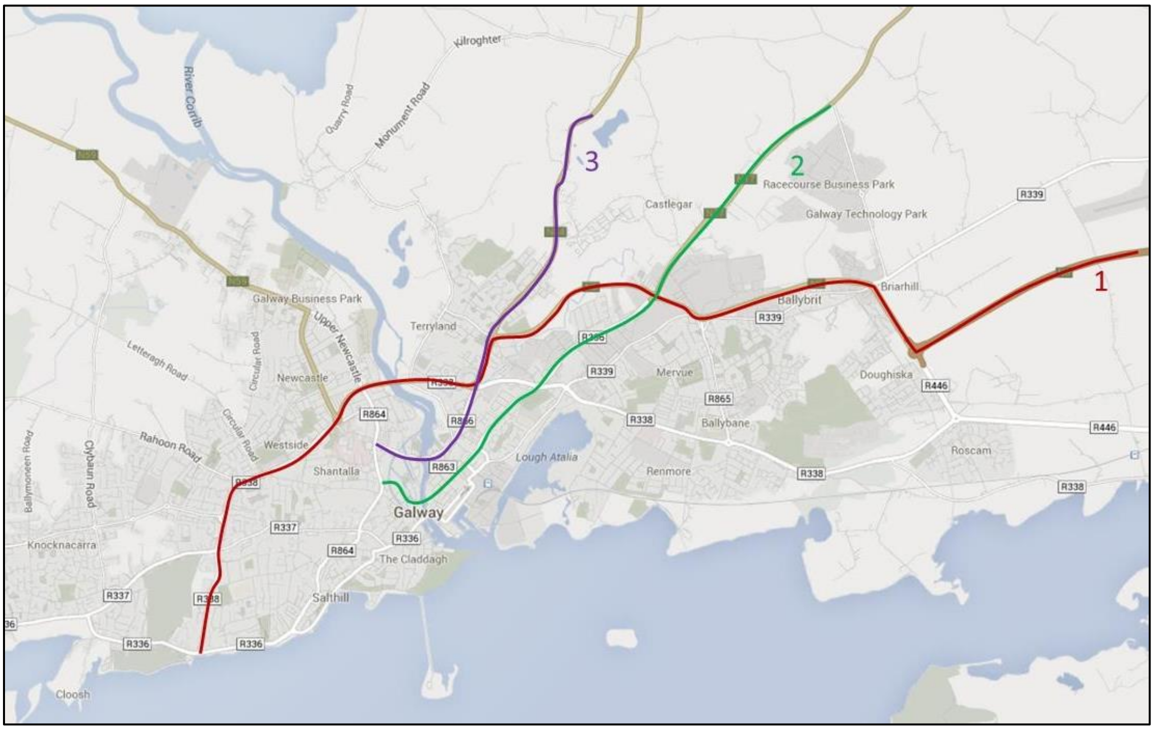
Observed travel times in 2012 Base Year on each of the routes in the inbound direction in the morning peak period versus the off-peak period are tabulated in **Table 2.2** below.

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 2.2: 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%

Figure 2.6: Journey Time Reliability Routes



2.4.3.5 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 **Figure 2.7**. 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.

Figure 2.7: Volume/Capacity Ratios at Junctions (2012)

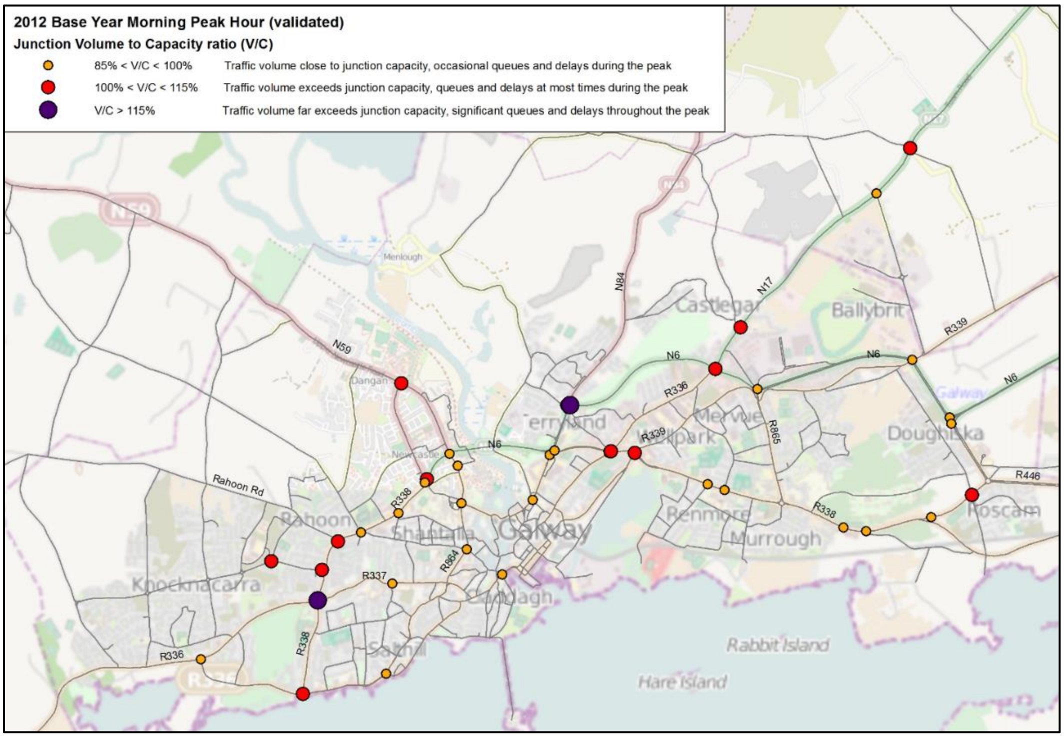


Table 2.3 summarises the number of junctions with a max turn RFC within standard ranges of 0.85-1.00, 1.00-1.15 and >1.15. Junctions with a RFC greater than 1 are over capacity. Ideally junctions should operate at a RFC ratio of < 0.85 (or 0.90 for signalised junctions), which would allow 15% spare capacity 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 **Figure 2.7** 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 2.3: 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

Sector	Sector Name	0.85 – 1.00	1.00 – 1.15	> 1.15
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

2.4.3.6 Alternative Modes

2.4.3.6.1 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.

2.4.3.6.2 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 Station, 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.

2.4.3.6.3 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.

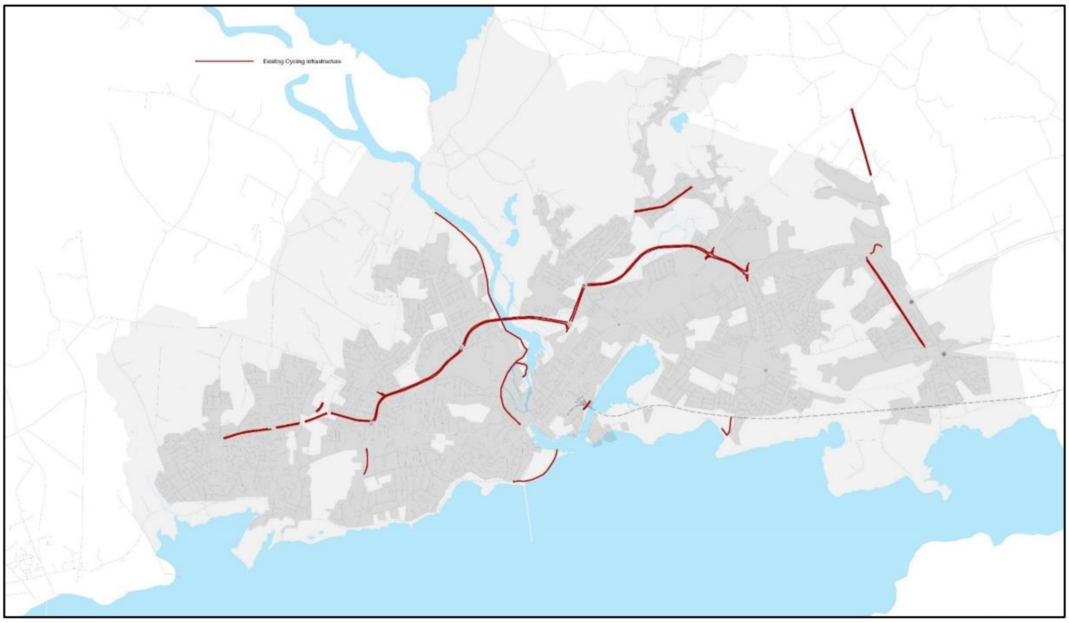
2.4.3.6.4 Existing Cycle Network

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.

Figure 2.8 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.

Figure 2.8: Extent of Existing Cycle Network Infrastructure



2.4.4 Future Environment / Proposed Road Development

2.4.4.1 Characteristics of the Proposed Road Development

The proposed road development, as described in detail in **Chapter 3, Alignment Geometry**, 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 Drawings **GCOB-000-D-000** to **015** in **Appendix A.1**.

2.4.4.1.1 Proposed Road Corridor 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 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 3, Alignment Geometry**.

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 DN-GEO-03036.

The design speed of the mainline over this area is 100km/h and cross section is as outlined within **Chapter 3, Alignment Geometry**.

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.

2.4.4.2 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.

2.4.4.2.1 TEN-T Network

As discussed above, 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."

2.4.4.3 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

2.4.4.3.1 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

2.4.4.4 Future Transportation Network

2.4.4.4.1 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.2.1**). 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

2.4.4.4.2 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".

2.4.5 Assessment of Proposed Road Development using Traffic Model

2.4.5.1 Travel Demand Forecasts

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.

2.4.5.2 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. The two 'development' scenarios are entitled Do-Something 2024 and Do-Something 2039.

2.4.5.3 Scenarios Tested

2.4.5.3.1 Modelled Scenarios

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.

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 2.4.5.1**.

2.4.6 Traffic Impact Assessment

2.4.6.1 Identification and Scale of impacts

The impact assessment identifies and measures 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. were also 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.

Three Key Performance Indicators (KPI) were identified which assist in the assessment and evaluation process of the proposed road development 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.

2.4.6.1.1 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 2.4** below.

The journey time routes used for the assessment of impact are shown in **Figure 2.9**. This KPI, therefore, assesses the strategic traffic impact of the proposed road development.

Figure 2.9: Journey Time Routes

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 2.4: 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

Table 2.4 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 2.4.6.3.1**.

2.4.6.1.2 Network Statistics

To further quantify the impact of the proposed road development 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 2.4.6.3.2**.

2.4.6.1.3 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 to capacity (RFC) at key junctions along the existing N6 corridor has 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 **Figure 2.10** 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.

Figure 2.10: 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 2.5,** below, refers to roundabouts and other priority junctions and **Table 2.6** refers to signalised junctions and summarises how the change in the value of these parameters indicates the performance impact.

Table 2.5: 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 2.6: 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.

This analysis is presented at **Section 2.4.6.3.3**.

2.4.6.2 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 are rated as short, medium or long term. As per EPA guidelines on the preparation of Environmental Impact Statements, 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.

2.4.6.3 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 are for the Core Scenarios which utilise the Medium Growth Forecasts. The evaluation of Low and High growth sensitivity tests are summarised within **Section 2.4.6.6.3** with further detail in the Traffic Modelling Report in **Appendix A.2.1**.

2.4.6.3.1 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, namely 2024 DM and DS plus 2039 DM and DS, for Medium Growth Forecasts. **Figure 2.9** illustrates each of the journey time routes which have been analysed.

Table 2.7: 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 2.8: 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 2.9: 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 2.10: 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 2.11: 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 2.12: 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 2.13: 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 2.14: 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	817	26.0	689	11.5	-868	-55.7%
Route 4b – Inbound	772	12.9	633	10.6	-139	-18.0%
Route 4b – Outbound	1474	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 2.15: 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 2.16: 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 2.17: 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 2.18: 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%

2.4.6.3.2 Network Statistics Analysis (2024 and 2039)

The tables below present Network Statistics from each modelled time-period for all medium growth scenarios.

Table 2.19: 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-Min	223,666	7,576	2,274	29.5	-
2024 Do-Something	258,719	6,798	1,505	38.1	Positive
2039 Do-Min	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 2.20: 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-Min	148,147	4,321	920	34.3	-
2024 Do-Something	163,308	4,144	767	39.4	Positive
2039 Do-Min	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 2.21: 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-Min	173,045	5,164	1,124	33.5	-
2024 Do-Something	192,752	5,023	980	38.4	Positive
2039 Do-Min	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 2.22: 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-Min	206,659	6,669	1,824	31	-
2024 Do-Something	233,756	6,135	1,318	38.1	Positive
2039 Do-Min	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.

2.4.6.3.3 Ratio of Flow to Capacity at Key Junctions

Core Scenarios

The tables below summarise the junction evaluations for the 2024 and 2039-Medium Growth Scenarios.

Table 2.23: 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 2.24: 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 2.25: 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 2.26: 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 2.27: 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 2.28: 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 2.29: 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 2.30: 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.

2.4.6.4 Assessment of Impact Significance

2.4.6.4.1 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.

2.4.6.4.2 Impact Significance 2039

In 2029 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.

2.4.6.5 Construction Impacts

Construction traffic impacts, and associated mitigation measures, of the proposed road development are considered in detail in **Chapter 13, Construction Phasing, Traffic & Waste Management**.

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 are identified and are outlined in **Chapter 13, Construction Phasing, Traffic & Waste Management**.

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 36month 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 EIA Report 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.

2.4.6.6 Cumulative Impacts

2.4.6.6.1 Transport Schemes

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 complimentary 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.

2.4.6.6.2 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.

2.4.6.6.3 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 2.4.2.3.2**:

- **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.

2.4.7 Mitigation Measures

2.4.7.1 Construction Phase

As noted, the construction of the proposed road development will cause temporary short-term traffic impacts on the local road network. The contractor shall ensure that construction traffic impacts are minimised through the control of site access/ egress routes and site access locations.

2.4.7.2 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, and as detailed within the GTS, demand management measures may be required which will ensure the capacity of the proposed road development is maintained. Some of these demand management measures, such as the integration of transport and land use planning, are detailed within the Galway Transport Strategy.

2.4.8 Residual Impacts

2.4.8.1 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.

2.4.8.2 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.

2.4.9 Forecast Traffic Flows

2.4.9.1 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.

Figure 2.11 illustrates the location of AADT points with corresponding AADT values shown in **Table 2.31**. 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.2.1**.

Table 2.31 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).

Figure 2.11: Proposed Road Development AADT Locations

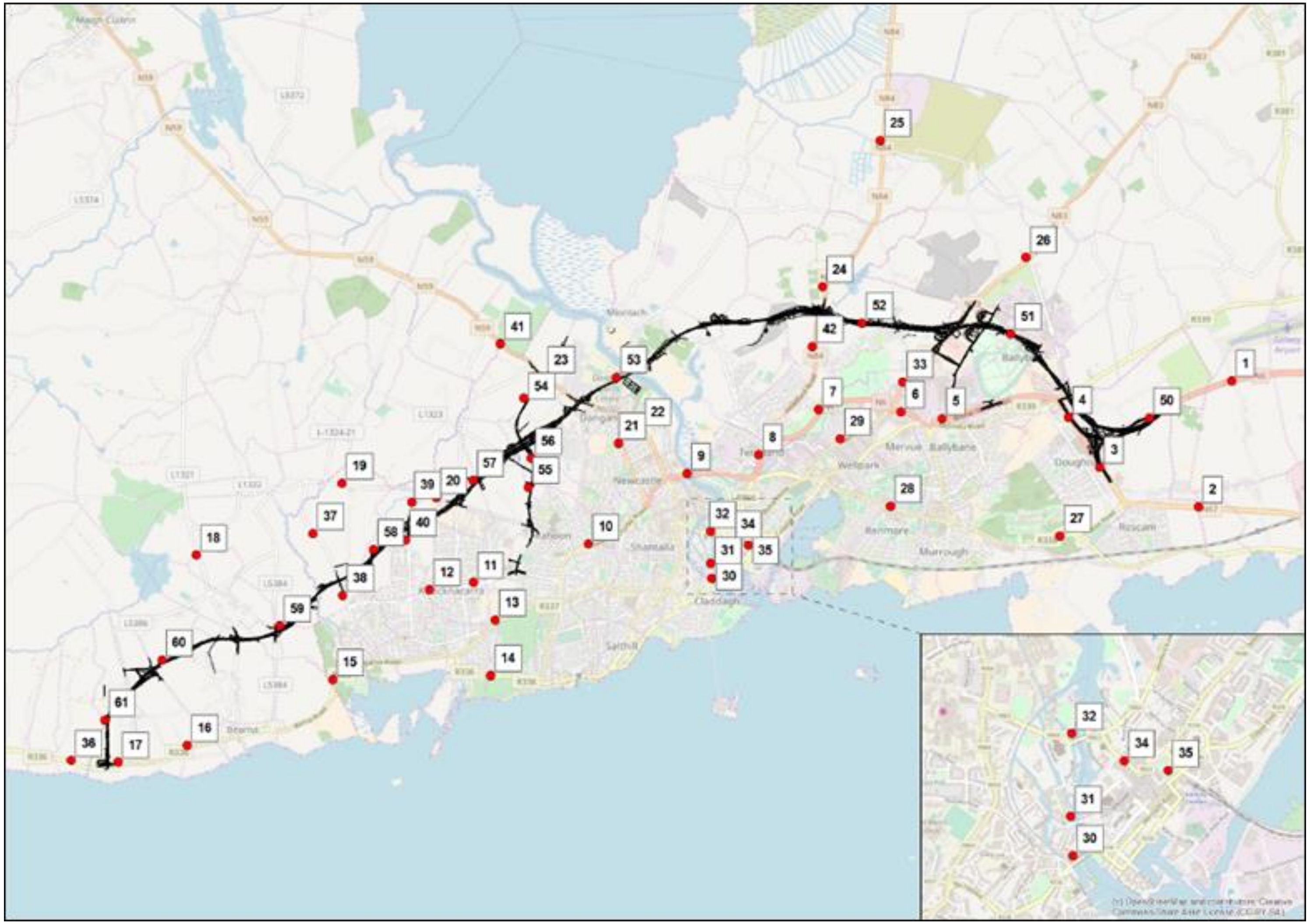


Table 2.31: Proposed Road Development AADT 2039 Design Year – Medium Growth

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 West of 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'Brien's 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	GCRR – Briarhill Junction			36,008	6%
51	GCRR – Parkmore			38,705	5%
52	GCRR – Between N83 and N84			49,876	5%
53	GCRR – New Corrib Crossing			36,353	4%
54	GCRR – N59 Link Road			11,530	4%
55	GCRR – Rahoon Link Road			6,172	3%
56	GCRR - Letteragh Link Road			13,709	3%
57	GCRR – Ballymoneen to N59			20,920	3%
58	GCRR – West of Ballymoneen			16,953	3%
60	GCRR – At Troscaigh West			11,155	3%
61	GCRR – North of Terminus			11,155	3%

2.4.9.2 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:

3. The **redistribution of trips** with the opening of the proposed road development
4. **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.

2.4.9.3 Galway Transport Strategy Forecasts

As outlined, 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 2.32 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 2.32: 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 2.33**. 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 2.33: 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 West of 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'Brien's 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%
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 Link 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 Troscaigh West			10,566	3%
61	GCRR – North of Terminus			10,566	3%

2.4.10 Summary

The traffic impact analysis carried out in **Section 2.4.6** 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. There will be no traffic negative impacts of major significance as a result of the introduction of the proposed road development.

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.15.1**) 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 3.88 for the central growth scenario, over the 30-year assessment period.

3 Alignment Geometry

The following chapter outlines the process by which the geometrical design of the proposed road development was undertaken. This chapter discusses the design speed, cross-section, horizontal and vertical design, stopping sight distance, safety barrier design, and relaxations and departures of the proposed mainline and side roads. This chapter also discusses the main alignments amendments outside of the Emerging Preferred Route Corridor (EPRC). The following chapter shall be read in conjunction with GCOB-100-D Series drawings in **Volume 2**.

3.1 Standards

The design of the proposed road development was undertaken in accordance with Transport Infrastructure Ireland (TII) current design publications.

In particular, adherence to the following standards is the basis of the Design:

- DN-GEO-03031 – Road Link Design
- DN-GEO-03036 – Cross-sections and Headroom
- DN-GEO-03060 – Geometric Design of Junctions (priority junctions, direct accesses, roundabouts, grade separated and compact grade separated junctions)
- DN-GEO-03044 – 2009 TII addendum to UK DMRB TD 50/04 - Geometric Layout of Signal Controlled Junctions and Signalised Roundabouts
- DN-GEO-03057 – Geometric Design to Improve Surface Drainage
- DN-PAV-03021 – Pavement & Foundation Design
- DN-DNG-03022 – Drainage Systems for National Roads

In addition to the above design publications, further guidance was drawn as necessary from relevant published data.

The proposed road development, where applicable to urban roads and streetscapes, has been designed in accordance with the Design Manual for Urban Roads and Streets (DMURS) as published by the Department for Transport, Tourism and Sport (DTTAS).

The design for Phases 5 and 6 of the TII project management guidelines shall be designed in accordance with the TII, DTTAS, NTA and other relevant design standards current at that time.

As outlined in DN-GEO-03031, '*the road alignment shall be designed to ensure that the standards of curvature, visibility, superelevation, etc. are provided for a Design Speed which shall be consistent with the anticipated vehicle speeds on the road. Design speed is related to the road characteristics and is not directly related to mandatory speed limits*'.

This standard also acknowledges that there is an economic trade-off between the construction and environmental costs of different Design Speeds and the user benefits generated by each. Section 6.3 of DN-GEO-03031 notes that it is more difficult to define a standard set of parameters for urban roads as the constraints of the existing urban fabric will result in designs tailored to meet site-specific requirements.

The design speeds available for consideration within the TII Publications are set out in **Table 3.1** below, taken from DN-GEO-03031.

Table 3.1: Maximum Design Speeds for Mandatory Speed Limits

Speed Limit km/h	Design Speed km/h
30	50B
50	60B
60	70B
80	85
100	100
120	120

3.1.1 Mainline

A design speed of 85km/h, with a mandatory speed limit of 80km/h, was established for the Type 1 Single Carriageway from the R336 to the Ballymoneen Road following an incremental assessment of cross-section alternatives and consultation with TII.

A design speed of 100km/h, with a mandatory speed limit of 100km/h, was established for the Dual Carriageway between Ballymoneen Road and the N59 Grade separated junction.

A design speed of 100km/h, with a mandatory speed limit of 100km/h, was established for the Urban Motorway between the N59 grade separated junction and the N6 Coolagh Junction.

3.1.2 Link Roads

There are two main link roads designed as part of the proposed road development:

N59 Link Road

The N59 Link Road is a 2km single carriageway which connects north and south of proposed road development at Letteragh by means of a signalised diamond grade separated junction. The link road connects from proposed road development to the existing N59 Moycullen Road on the North and to the Letteragh Road and Rahoon Road on the South with at-grade signalised junctions.

As the N59 Link Road is located in a largely urban and residential area the design speed for the N59 Link Road is 60km/h. This link road has been designed to cater for pedestrians and cyclists with a footpath in both directions and a cycle lane over a portion of it. The N59 Link Road will likely have a mandatory speed limit of 50km/h to promote a safer environment for all modes.

Parkmore Link Road

The Parkmore Link Road is a 1.3km single carriageway which forms part of the N83 Tuam Road grade separated junction. The link road connects both the IDA Parkmore Industrial Estate and the City East Business Park providing a new access/egress to both estates. Westbound traffic from the proposed road development mainline can diverge to the Parkmore Link Road and eastbound traffic can merge from the Parkmore Link Road to the proposed road development. There is also a proposed interconnector link road between the N83 Tuam Road and the Parkmore Link Road, namely City North Business Park Link.

The Parkmore Link Road design speed is 60km/h. This link road has also been designed to cater for pedestrians and cyclists with a 2m wide cycle lane and 1.8m wide footpath in both directions. The Parkmore Link Road will likely have a mandatory speed limit of 50km/h to promote a safer environment for all modes.

3.1.3 Slip Roads

There are four main grade separated interchanges along the proposed road development where slip roads are located, namely:

- N59 Letteragh Junction - 4 No. Slip roads
- N84 Headford Road Junction - 4 No. Slip roads
- N83 Tuam Road / Parkmore Link Road Junction - 4 No. Slip roads
- Coolagh Junction - 4 No. Slip roads

All slip roads have been designed in accordance with design speeds specified in DN-GEO-03060 Table 7.6 Connector Road Design Speed. An Urban Motorway with a design speed of 100km/h specifies a 60km/h design speed for slip roads.

3.2 Cross-section

During Phase 2 Route Selection detailed traffic modelling was completed for all the route options developed. An incremental assessment was undertaken to establish the most appropriate cross-section for the scheme. The conclusion of this assessment was that it would be necessary to provide a single carriageway from the R336 Coast Road to Ballymoneen Road and dual carriageway thereafter to the N6 tie-in at Coolagh, Briarhill.

Traffic analysis cannot be the only variable upon which the cross-section is selected. Further guidance on the selection of an appropriate cross-section is provided within TA 30/82 *"Choice between Options for Trunk Road Schemes"* of the UK Design Manual for Roads and Bridges. A holistic approach to the decision-making process is provided within this guidance. This approach proposes that the cross-section should not be chosen with respect to road capacity alone. It sets out that the assessment should include economic, policy and environmental criteria in order to ensure a more complete assessment is undertaken.

During Phase 3 Design, further work was undertaken in relation to the cross-section selection. This in particular focussed on the area between the Ballymoneen Road to the existing N6 tie-in.

3.2.1 Trans-European Network (TEN-T)

The European Union has set out a strategic transport infrastructure policy for the region that connects right across the member states from east and west to north and south. The routes are identified in the trans-European transport network (TEN-T). Refer to **Figure 2.2** in **Section 2.2.2** which outlines the TEN-T Network for Ireland.

As the proposed road development will form part of the Comprehensive TEN-T road network in Ireland, it is necessary that the chosen cross-section comply with regulations in this regard. The cross-sections suitable for use on the TEN-T Comprehensive network are listed as follows:

- Motorways
- Expressway
- Conventional Strategic Roads

3.2.2 Road Type

In general, the standards describe two broad types of roads, namely Rural Roads and Urban Roads, and the selection of either depends on its location and setting. The proposed road development is located in rural, suburban and urban areas over its length with the majority located inside the Galway City boundary.

A preliminary analysis based solely on traffic flow to determine the most appropriate cross-section was undertaken, this was based on predicted traffic volumes for the preferred route corridor with a Design Year of 2039 and hourly peak flows from the AM Peak. This analysis is tabulated in **Table 3.2** below. TII DN-GEO-03031 - Road link design was used to assess the capacity of Rural Road types. The UK DMRB TA79/99 – Traffic Capacity of Urban Roads document was used to assess the capacity of Urban Roads (note that TII standard DN-GEO-03036 states that Table 6.1 of DN-GEO-03031 does not apply to Urban Roads).

Table 3.2: Cross-Section Assessment

Location	**Setting**	**Anticipated AADT versus DN-GEO-03031 Table 6/1**	**TII DN-GEO-03031 Table 6.1**	**UK DMRB TA/79**	
Bearna to Cappagh Road	Rural	11,300 < 11,600	Type 1 Single	N/A	UAP1 (Single)
Cappagh Road to Ballymoneen Road	Suburban	17,300 < 20,000	Type 2 Dual	<1590 UAP1 (Single)	

Location	Setting	Anticipated AADT versus DN-GEO-03031 Table 6/1	TII DN-GEO-03031 Table 6.1	UK DMRB TA/79	
Ballymoneen to N59	Suburban	21,400 < 42,000	Type 1 Dual	<1590 UAP1 (Single)	UAP1 (Dual)
N59 to N84	Urban	37,170 < 42,000	Type 1 Dual	UAP1 (Dual)	
N84 to N83	Urban	50,895 < 55,500	Wide motorway	UAP1 (Dual)	
N83 to N6	Urban	40,330 < 42,000	Type 1 Dual	UAP1 (Dual)	

It is clear from the above that there are two distinct levels of cross-section provision required for the length of this scheme with the split point being at Ballymoneen Road junction, which effectively gives two separate links for analysis as follows:

- Section 1 - R336 to Ballymoneen Road
- Section 2 - Ballymoneen Road to the N6

Following assessment using TII DN-GEO-03031, and given its largely rural and suburban environment a Type 1 single carriageway cross-section (CC-SCD-00001) was deemed an appropriate level of provision from the R336 to Ballymoneen Road (i.e. Section 1 of the proposed road development).

Following assessment using DMRB TA/79, it was determined that a dual carriageway cross-section (CC-SCD-00007-06) be provided from Ballymoneen Road to the N6 Coolagh. From Ballymoneen Road to the N6 at Coolagh (i.e. Section 2) urban design standards should be adopted given the environment and traffic volumes anticipated.

3.2.3 Proposed Road Development Mainline

As outlined above a Type 1 Single Carriageway (S2) was chosen for the section west of Ballymoneen Road Junction and a dual carriageway for the section east of the Ballymoneen Road Junction. Based on the status of the N6 GCRR route as being part of the comprehensive TEN-T network, the single carriageway will form part of a Protected Road Scheme statutory designation. There are two proposed designations for the dual carriageway section, with the Type 1 Dual Carriageway from Ballymoneen Road to the N59 Letteragh Junction being part of the Protected Road Scheme.

The N59 Letteragh Junction to the tie in with N6 at Coolagh, Briarhill will be an Urban Motorway, this will form part of a Motorway Scheme statutory designation. The cross-section is the same for both the Type 1 Dual Carriageway and Urban Motorway. The above designations (Protected Road Scheme and Motorway

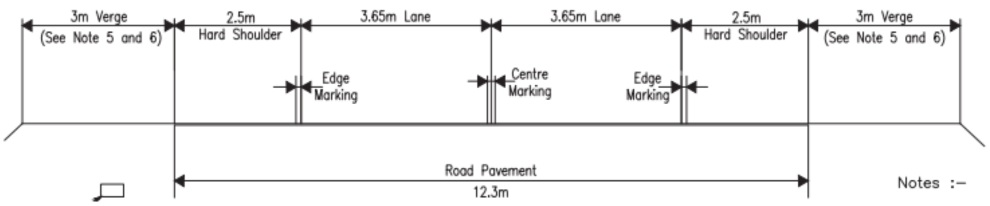
Scheme) are compliant with the road types outlined in **Section 3.2.1** above for the comprehensive network.

3.2.3.1 R336 to the Ballymoneen Road Junction

The cross-section for the proposed road development mainline from the R336 to the Ballymoneen Road Junction is in accordance with the TII DN-GEO-03036 Table 3.2 - Type 1 Single Carriageway and is summarised below. **Figure 3.1** presents a typical cross-section.

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**

Figure 3.1: CC-SCD-00001 – Type 1 Single Carriageway (S2)



There are two locations where climbing lanes are required. These are located at Ch. 0+030 to Ch. 0+860 (eastbound) and Ch. 1+850 to Ch. 2+770 (westbound). These are designed in accordance with DN-GEO-03031 and will add another 3.7m wide lane in the direction of climbing.

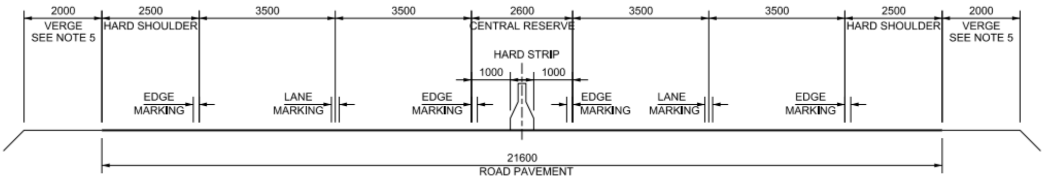
3.2.3.2 Ballymoneen Road Junction to the N6 Coolagh, Briarhill

The cross-section for the proposed road development mainline from Ballymoneen Road Junction to the N6 tie in at Coolagh, Briarhill is in accordance with the DN-GEO-03036 Table 3.2 - Rural All-Purpose Roads (Type 1 Dual) and Table 3.3 - Urban Motorway and is summarised below. **Figure 3.2** presents a typical cross-section.

Western Verge Width (minimum):	2.0m
Western Hard Shoulder Width (minimum):	2.5m
Western Carriageway Width:	7.0m (2 x 3.5m lanes)
Central Reserve Width (minimum): offside hardstrip)	2.6m (including 2 x 1.0m
Eastern Carriageway Width:	7.0m (2 x 3.5m lanes)

Eastern Hard Shoulder Width (minimum):	2.5m
Eastern Verge Width (minimum):	2.0m
Total Width (minimum):	**27.6m**

Figure 3.2: CC-SCD-00007 – Standard Dual Carriageway Motorway (D2M) & (D2UM)



Between the grade separated junctions at the N84 Headford Road and the N83 Tuam Road 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 high level of traffic predicted at 50,900 AADT and to cater for weaving and merging between the two grade separated junctions.

3.2.3.3 Single to Dual Carriageway Transition

The transition from single to dual carriageway and vice versa occurs at the Ballymoneen signalised junction and will be marked and sign posted appropriately to provide advance warning to the user. To enhance safety through the junction dual lanes are provided on approach and departure west of the Ballymoneen Junction for a length of 100m. The lane gain and lane drop are tapered at an appropriate rate to allow safe transition from dual to single on the approach to and departure from the junction.

3.2.3.4 Major Structures

The typical cross-section through the tunnels at Lackagh Tunnel and the Galway Racecourse Tunnel differ from that required for a Standard Dual Carriageway and Urban Motorway in accordance with DN-GEO-03036. The cross-section of tunnels is dictated by national and international best practice with respect to tunnel layouts, geometric parameters such as stopping sight distance, the provision of adequate space for operational equipment and the provision of safe access and egress routes in cases of emergency are all considered (UK DMRB BD78, PIARC World Road Tunnels Manual). As a result, the carriageway lanes are increased to 3.75m wide and hard shoulders are reduced from 2.5m to 0.5m hard strips. Both nearside and offside emergency walkways areas are provided which have a minimum of 1.2m in width. A minimum maintained headroom of 5.3m is provided in both tunnels.

At the River Corrib Bridge and Menlough Viaduct hard shoulder widths reduce to 0.5m with a reduced raised verge of 0.6m, total cross-section reduces to a minimum width of 19.3m (excluding widening requirements for forward visibility).

Refer to **Chapter 7, Structures** of this design report for further information on verge reduction at structures in accordance with TII DN-GEO-03036.

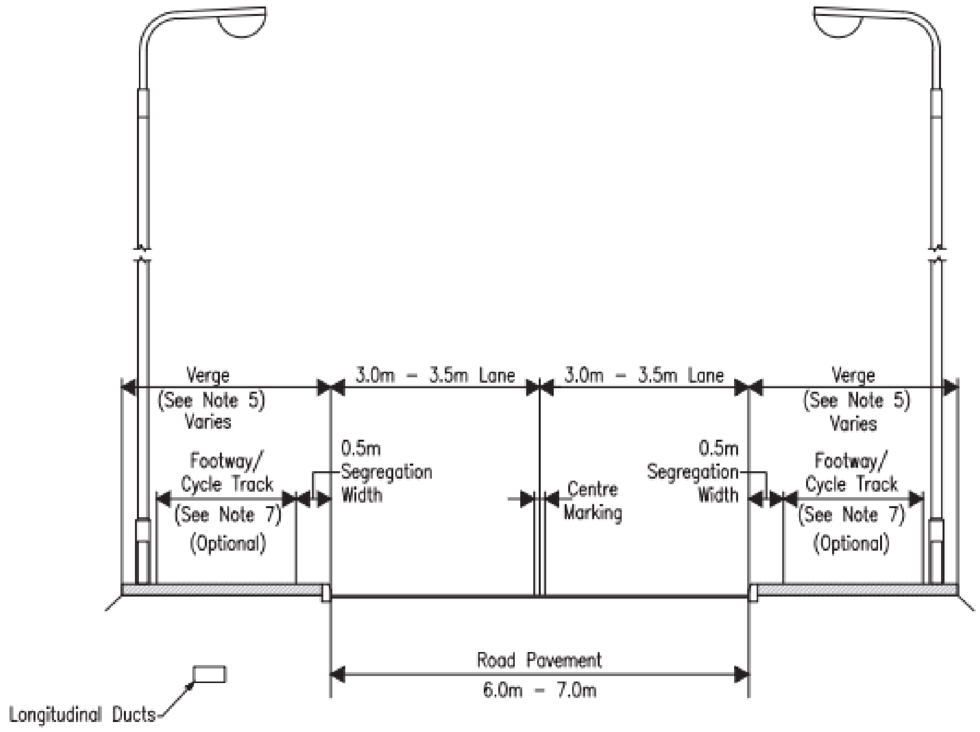
3.2.4 Link Roads

The cross-sections for all link roads have been designed in accordance with TII DN-GEO-03036 Table 3.4 – Urban All-Purpose Roads. Additional requirements for pedestrian and cycle lane widths have been included in accordance with the measures outlined in the Galway Transport Strategy (GTS) for non-motorised users and are summarised in **Table 3.3** below. **Figure 3.3** presents a typical cross-section.

Table 3.3: Link Road Cross-sections

Link Road	Carriageway Width (m)	Cycle Lane Width (m)	Footpath Width (m)	Verge Width (m)	Total Width (m)
N59 Link Road North	2 x 3.5 lanes	N/A	2 x 2.0	2 x 0.5	12.0
N59 Link Road South (N59 Letteragh Junction to Letteragh Road)	2 x 3.5 lanes	N/A	2 x 2.0	2 x 0.5	12.0
N59 Link Road South (Letteragh Road to Rahoon Road)	2 x 3.5 lanes	2 x 2.0 lanes from Letteragh Road Junction to Rahoon Road Junction	2 x 1.8 from Letteragh Road Junction to Rahoon Road Junction	2 x 0.5	15.6
Parkmore Link Road	2 x 3.5 lanes	2 x 2.0m lanes	2 x 2.0	N/A	15.0
City North Business Park Link Road (N83 to Parkmore Link Road)	2 x 3.5 lanes	2 x 2.0m lanes	2 x 2.0	2x1.0	17.0

Figure 3.3: Single Carriageway Urban Relief Road



3.2.5 Slip Roads

The cross-section for all slip roads have been designed in accordance with TII DN-GEO-03036 Table 3.3 – Urban Motorways. The details have been extracted below in **Table 3.4**.

Table 3.4: Slip Road - Cross-sections

Lanes	Nearside Verge (m)	Nearside Hard Strip (m)	Carriageway Width (m)	Offside Hard Strip (m)	Offside Verge (m)
1	Varies	1.5	4.0	0.5	Varies
2 (Diverge Only)	Varies	1.0	6.0	0.5	Varies

3.2.5.1 Merge and Diverge Layouts

Cross-sections for merge and diverges on the proposed road development have been determined following hourly flow checks (vph) in accordance with DN-GEO-03060. In general Type A Parallel Merges have been designed as minimum as per Figure 7.4.1 DN-GEO-03060 and Type A Single Parallel Diverges have been provided as a minimum as per Figure 7.6.1 DN-GEO-03060.

Type B Single Lane Parallel Diverges showing 2 x 3.0m Diverging Lane Connector Road as per Figure 7.6.2 DN-GEO-03060 have been designed at the N59 Letteragh

Junction westbound diverge, N84 Headford Road westbound diverge and the N83 Tuam Road/Parkmore westbound and eastbound diverge. See also **Section 3.11** below for alternative merge layouts used at the N83 and N84 following a weaving design assessment. Further details are provided in **Chapter 4, Junction Strategy** and **Table 4.1** summarises the merge and diverge layout types used at each grade separated junction.

3.3 Principal Geometric Parameters

Table 3.5 summarises the key geometric design parameters applicable to all roads contained within the project.

Table 3.5: Geometric Design Parameters for Major and Minor Roads

Road Type	Design Speed (km/h)	Minimum Curve Radius (m) without Super-elevation	Minimum Curve Radius (m) with 5% Super-elevation	Minimum Longitudinal Gradient (%)	Maximum Gradient (%)	Minimum Sag Curve Value (K)	Minimum Crest Curve Value (K)
National Roads							
N6 Dual Carriageway / Urban Motorway	100	2040	720	1.00	3.00	37.00	100.00
N6 Type 1 Single Carriageway	85	1440	510	1.00	5.00	26.00	55.00
Link / Local Roads							
N59 Link Road	60	720	255	1.00	6.00	13.00	17.00
Parkmore Link Road	60	720	255	1.00	6.00	13.00	17.00
Other Roads							
Access Roads	30			-	-		

3.4 Horizontal Design

3.4.1 Mainline

Mainline Section 1 – R336 to Ballymoneen

The design of the N6 Single Carriageway from R336 to Ballymoneen Road horizontal alignment has been developed using appropriate geometric standards applicable to a design speed of 85km/h and the road cross-sections as detailed in **Section 3.2.3** above. **Table 3.6** below provides a list of the geometric elements in the Design, which can be summarised as follows:

- Total number of elements (excluding transitions) = 15
- No. of curves below desirable minimum radius (510m for 85km/h) = 0
- No. of desirable minimum curve radii = 1
- No. of curves with radius between desirable minimum and 1440 = 5
- No. of curves with radii equal to or greater than 1440 = 4

Table 3.6: Horizontal Design Elements - Mainline Section 1

No.	Element Type			Start Chainage	End Chainage	Radius (m)	Length (m)	Hand of Arc
1	-	Arc	-	0+031	0+104	1020	73.331	Left
2	-	-	Transition	0+104	0+166	-	61.500	-
3	Straight	-	-	0+166	0+475	-	308.681	-
4	-	-	Transition	0+475	0+567	-	93.000	-
5	-	Arc	-	0+567	0+938	510	370.252	Right
6	-	-	Transition	0+938	1+031	-	93.000	-
7	-	Arc	-	1+031	1+350	2300	319.176	Left
8	-	-	Transition	1+350	1+423	-	74.000	-
9	-	Arc	-	1+424	1+612	720	188.476	Right
10	-	-	Transition	1+612	1+686	-	74	-
11	Straight	-	-	1+686	1+970	-	284.022	-
12	-	Arc	-	1+970	2+222	5000	251.804	Left
13	-	-	Transition	2+222	2+296	-	73.700	-
14	-	Arc	-	2+298	2+797	720	501.007	Right
15	-	Arc	-	2+799	3+802	1020	1003.420	Left
16	-	-	Transition	3+802	3+863	-	61.000	-
17	Straight	-	-	3+863	3+960	-	97.150	-
18	-	-	Transition	3+960	4+034	-	74.000	-
19	-	Arc	-	4+034	4+337	720	302.297	Right

No.	Element Type			Start Chainage	End Chainage	Radius (m)	Length (m)	Hand of Arc
20	-	-	Transition	4+337	4+410	-	73.800	-
21	Straight	-	-	4+410	4+455	-	44.732	-
22	-	Arc	-	4+445	4+998	1440	543.307	Left
23	Straight	-	-	4+998	5+189	-	190.625	-
24	-	Arc	-	5+189	5+640	1440	450.786	Right

Mainline Section 2 – Ballymoneen to N6 Coolagh

The horizontal alignment design of the N6 Dual Carriageway from Ballymoneen to the N6 / M6 at Coolagh has been developed using appropriate geometric standards applicable to a design speed of 100km/h and the road cross-sections as detailed in **Section 3.2.3** above. **Table 3.7** below provides a list of the geometric elements in the Design, which can be summarised as follows:

- Total number of elements (excluding transitions) = 22
- No. of curves below desirable minimum radius (720m for 100km/h) = 0
- No. of desirable minimum curve radii = 2
- No. of curves with radius between desirable minimum and 2040 = 8
- No. of curves with radii equal to or greater than 2040 = 9

Table 3.7: Horizontal Design Elements - Mainline Section 2

No.	Element Type			Start Chainage	End Chainage	Radius (m)	Length (m)	Hand of Arc
1	-	Arc	-	5+640	5+766	1440	126.457	Right
2	-	-	Transition	5+766	5+824	-	58.000	-
3	-	-	Transition	5+824	5+882	-	58.000	-
4	-	Arc	-	5+882	6+191	1750	308.855	Left
5	-	-	Transition	6+191	6+307	-	115.982	-
6	-	Arc	-	6+307	6+747	1996	437.551	Left
7	-	Arc	-	6+747	7+347	2100	600.148	Right
8	Straight	-	-	7+347	7+974	-	626.556	-
9	-	Arc	-	7+974	8+310	2040	336.594	Left
10	Straight	-	-	8+310	8+474	-	163.995	-
11	-	-	Transition	8+474	8+579	-	105.000	-
12	-	Arc	-	8+579	8+965	1440	385.420	Right
13	-	-	Transition	8+965	9+070	-	105.000	-
14	-	Arc	-	9+070	9+846	2000	776.529	Left
15	-	-	Transition	9+846	9+972	-	126.000	-

No.	Element Type			Start Chainage	End Chainage	Radius (m)	Length (m)	Hand of Arc
16	-	Arc	-	9+972	10+311	1020	338.583	Right
17	-	-	Transition	10+311	10+331	-	20.708	-
18	-	Arc	-	10+331	10+781	1440	449.544	Left
19	-	-	Transition	10+781	10+906	-	125.000	-
20	Straight	-	-	10+906	11+006	-	99.650	-
21	-	Arc	-	11+006	11+607	2040	601.011	Left
22	-	-	Transition	11+607	11+772	-	165.000	-
23	-	Arc	-	11+772	12+078	720	306.299	Left
24	-	-	Transition	12+078	12+243	-	165.000	-
25	-	Arc	-	12+243	12+822	2040	579.605	Right
26	-	Arc	-	12+822	13+496	20000	673.280	Right
27	-	Arc	-	13+496	14+020	2040	524.446	Left
28	-	-	Transition	14+020	14+146	-	126.000	-
29	-	Arc	-	14+146	15+109	1020.4	963.011	Right
30	-	-	Transition	15+109	15+235	-	126.000	-
31	-	Arc	-	15+235	15+544	8000	308.966	Left
32	-	Arc	-	15+544	15+893	2040	348.774	Right
33	-	-	Transition	15+893	16+118	-	225.000	-
34	-	Arc	-	16+118	17+094	720	976.232	Left
35	-	-	Transition	17+094	17+319	-	225.000	-
36	-	Arc	-	17+319	17+540	2040	221.253	Right

3.4.2 Link Roads

The horizontal alignment design of the link roads at Letteragh and Parkmore has been developed using appropriate geometric standards applicable to a design speed of 60km/h and the road cross-sections as detailed in **Section 3.2.4** above.

3.4.2.1 N59 Link Road

Table 3.8 below provides a list of the geometric elements in the Design of the N59 Link Road, which can be summarised as follows:

- Total number of elements (excluding transitions) = 12
- No. of curves below desirable minimum radius (255m for 60km/h) = 2
- No. of desirable minimum curve radii = 0
- No. of curves with radius between desirable minimum and 720 = 3
- No. of curves with radii equal to or greater than 720 = 1

Table 3.8: Horizontal Design Elements – N59 Link Road

No.	Element Type			Start Chainage	End Chainage	Radius(m)	Length(m)	Hand of Arc
1	Straight	-	-	0+000	0+589	-	589.293	-
2	-	-	Transition	0+589	0+628	-	38.500	-
3	-	Arc	-	0+628	1+012	360	383.750	Left
4	-	-	Transition	1+012	1+050	-	38.500	-
5	Straight	-	-	1+050	1+155	-	104.759	-
6	-	-	Transition	1+155	1+205	-	50.630	-
7	-	Arc	-	1+205	1+373	300	167.960	Right
8	-	-	Transition	1+373	1+424	-	50.630	-
9	Straight	-	-	1+424	1+464	-	40.460	-
10	-	Arc	-	1+464	1+618	1020	153.923	Right
11	Straight	-	-	1+618	1+830	-	211.828	-
12	-	-	Transition	1+830	1+872	-	42.192	-
13	-	Arc	-	1+872	1+959	360	86.310	Left
14	-	-	Transition	1+959	2+001	-	42.192	-
15	Straight	-	-	2+001	2+102	-	100.786	-
16	-	Arc	-	2+102	2+157	150	55.267	Left
17	-	Arc	-	2+157	2+203	90	45.873	Right
18	Straight	-	-	2+203	2+227	-	24.457	-

3.4.2.2 Parkmore Link Road

Table 3.9 below provides a list of the geometric elements in the Design of the Parkmore Link Road, which can be summarised as follows:

- Total number of elements (excluding transitions) = 12
- No. of curves below desirable minimum radius (255m for 60km/h) = 3
- No. of desirable minimum curve radii = 0
- No. of curves with radius between desirable minimum and 720 = 0
- No. of curves with radii equal to or greater than 720 = 3

Table 3.9: Horizontal Design Elements - Parkmore Link Road

No.	Element Type			Start Chainage	End Chainage	Radius (m)	Length (m)	Hand of Arc
1	Straight	-	-	0+000	0+220	-	219.602	-
2	-	Arc	-	0+220	0+356	1020	136.177	Right
3	Straight	-	-	0+356	0+647	-	291.688	-
4	-	Arc	-	0+647	0+751	720	103.406	Left

No.	Element Type			Start Chainage	End Chainage	Radius (m)	Length (m)	Hand of Arc
5	Straight	-	-	0+751	0+952	-	200.920	-
6	-	Arc	-	0+952	1+019	2040	67.556	Right
7	-	-	Transition	1+019	1+068	-	48.833	-
8	-	Arc	-	1+068	1+092	180	23.618	Left
9	-	-	Transition	1+092	1+141	-	48.833	-
10	Straight	-	-	1+141	1+238	-	96.881	-
11	-	Arc	-	1+238	1+293	90	55.130	Right
12	Straight	-	-	1+293	1+301	-	8.450	-
13	-	Arc	-	1+301	1+383	90	82.070	Left
14	Straight	-	-	1+383	1+471	-	87.889	-

3.4.3 Slip Roads

The horizontal alignment design of all slip roads has been developed using appropriate geometric standards applicable to a design speed of 60km/h and the road cross-sections as detailed in **Section 3.2.3** above. **Table 3.10** to **Table 3.13** below provide a list of the geometric elements in the Design, which can be summarised as follows:

3.4.3.1 N59 Letteragh Junction

Table 3.10 below provides a list of the geometric elements in the Design of the N59 Letteragh Junction Slip Roads.

Table 3.10: Horizontal Design Elements – N59 Letteragh Junction

	No.	Element Type			Start Chainage	End Chainage	Radius (m)	Length (m)	Hand of Arc
East Bound Diverge	1	Straight	-	-	0+000	0+129	-	129.245	-
	2	-	Arc	-	0+129	0+187	1440	57.843	Right
	3	Straight	-	-	0+187	0+327	-	140.329	-
	4	-	Arc	-	0+327	0+345	1020	17.388	Right
	5	Straight	-	-	0+345	0+367	-	22.546	-
East Bound Merge	1	Straight	-	-	0+000	0+065	-	65.205	-
	2	-	Arc	-	0+065	0+353	1440	288.286	Right
	3	-	Arc	-	0+353	0+510	1020	156.957	Left
	4	Straight	-	-	0+510	0+541	-	31.047	-
West Bound Diverge	1	Straight	-	-	0+000	0+247	-	247.096	-
	2	-	Arc	-	0+247	0+326	720	78.812	Right
	3	Straight	-	-	0+326	0+495	-	169.205	-
West Bound Merge	1	Straight	-	-	0+000	0+035	-	35.052	-
	2	-	Arc	-	0+035	0+170	1020	135.322	Right
	3	-	Arc	-	0+170	0+336	1020	165.271	Left
	4	Straight	-	-	0+336	0+409	-	73.163	-

3.4.3.2 N84 Headford Road Junction

Table 3.11 below provides a list of the geometric elements in the Design of the N84 Headford Road Junction Slip Roads.

Table 3.11: Horizontal Design Elements – N84 Headford Road Junction

	No.	Element Type			Start Chainage	End Chainage	Radius (m)	Length (m)	Hand of Arc
East Bound Diverge	1	Straight	-	-	0+000	0+036	-	35.762	-
	2	-	Arc	-	0+036	0+450	720	414.570	Right
	3	Straight	-	-	0+450	0+508	-	58.031	-
East Bound Merge	1	Straight	-	-	0+000	0+017	-	16.898	-
	2	-	Arc	-	0+017	0+149	720	148.783	Right
	3	-	Arc	-	0+149	0+308	720	159.358	Left
	4	Straight	-	-	0+308	0+375	-	66.908	-
West Bound Diverge	1	Straight	-	-	0+000	0+182	-	181.930	-
	2	-	Arc	-	0+182	0+330	720	148.446	Right
	3	Straight	-	-	0+330	0+362	-	31.221	-
West Bound Merge	1	Straight	-	-	0+000	0+063	-	62.566	-
	2	-	-	Transition	0+063	0+092	-	29.782	-
	3	-	Arc		0+092	0+236	510	143.618	Left
	4	-	-	Transition	0+236	0+245	-	8.687	-
	5	-	Arc	-	0+245	0+410	720	165.484	Left
	6	Straight	-	-	0+410	0+450	-	39.976	-

3.4.3.3 N83 Tuam Road / Parkmore Link Road Junction

Table 3.12 below provides a list of the geometric elements in the Design of N83 Tuam Road / Parkmore Link Road Junction Slip Roads.

Table 3.12: Horizontal Design Elements – N83 Tuam Road / Parkmore Link Road Junction

	No.	Element Type			Start Chainage	End Chainage	Radius (m)	Length (m)	Hand of Arc
East Bound Diverge	1	Straight	-	-	0+000	0+128	-	127.792	-
	2	-	Arc	-	0+128	0+330	720	202.337	Left
	3	Straight	-	-	0+330	0+392	-	61.682	-
	4	-	-	Transition	0+392	0+474	-	82.500	-
	5	-	Arc	-	0+474	0+475	60*	0.374	Right
East Bound Merge	1	Straight	-	-	0+000	0+088	-	88.152	-
	2	-	-	Transition	0+088	0+133	-	45.000	-
	3	-	Arc	-	0+133	0+349	83**	216.201	Left
	4	-	-	Transition	0+349	0+409	-	60.000	-
	5	Straight	-	-	0+409	0+469	-	60.001	-
West Bound Diverge	1	Straight	-	-	0+000	0+007	-	6.902	-
	2	-	-	Transition	0+007	0+028	-	21.096	-
	3	-	Arc	-	0+028	0+212	720	184.359	Left
	4	-	-	Transition	0+212	0+266	-	53.250	-
	5	-	Arc	-	0+266	0+397	81**	130.995	Left
	6	-	-	Transition	0+397	0+457	-	60.000	-
	7	Straight	-	-	0+457	0+510	-	53.853	-
West Bound Merge	1	-	Arc	-	0+000	0+175	720	175.226	Left
	2	Straight	-	-	0+175	0+354	-	179.621	-

* Skew Approach to Junction

** Loop Geometry Applied

3.4.3.4 N6 Coolagh Junction

Table 3.13 below provides a list of the geometric elements in the Design of N6 Coolagh Junction Slip Roads.

Table 3.13: Horizontal Design – N6 Coolagh Junction

	No.	Element Type			Start Chainage	End Chainage	Radius (m)	Length (m)	Hand of Arc
East Bound Diverge	1	Straight	-	-	0+000	0+010	-	9.774	-
	2	-	Arc	-	0+010	0+045	720	34.762	Left
	3	-	-	Transition	0+045	0+083	-	38.469	-
	4	-	Arc	-	0+083	0+114	255	31.452	Left
	5	-	-	Transition	0+114	0+152	-	38.000	-
	6	-	-	Transition	0+152	0+190	-	38.000	-
	7	-	Arc	-	0+190	0+466	255	275.278	Right
	8	-	-	Transition	0+466	0+504	-	38.000	-
	9	Straight	-	-	0+504	0+513	-	8.883	-
East Bound Merge	1	-	Arc	-	0+000	0+009	505.048	8.714	Left
	2	-	-	Transition	0+009	0+029	-	20.104	-
	3	-	Arc	-	0+029	0+143	360	114.629	Left
	4	-	-	Transition	0+143	0+213	-	70.000	-
	5	Straight	-	-	0+213	0+249	-	35.489	-
	6	-	-	Transition	0+249	0+339	-	90.000	-
	7	-	Arc	-	0+339	0+448	360	108.933	Right
	8	-	-	Transition	0+448	0+478	-	30.000	-

	No.	Element Type			Start Chainage	End Chainage	Radius (m)	Length (m)	Hand of Arc
	9	-	-	Transition	0+478	0+508	-	30.000	-
	10	-	Arc	-	0+508	0+642	510	134.555	Left
	11	-	-	Transition	0+642	0+672	-	30.000	-
	12	Straight	-	-	0+672	0+673	-	0.339	-
West Bound Diverge	1	-	Arc	-	0+024	0+067	720.000	43.644	Right
	2	-	-	Transition	0+067	0+127	-	59.979	-
	3	Straight	-	-	0+127	0+308	-	180.879	-
	4	-	-	Transition	0+308	0+393	-	84.677	-
	5	-	Arc	-	0+393	1+030	510.000	637.455	Right
	6	-	-	Transition	1+030	1+080	-	50.000	-
	7	Straight	-	-	1+080	1+213	-	133.005	-
West Bound Merge	1	-	Arc	-	0+000	0+011	858.789	10.760	Left
	2	-	-	Transition	0+011	0+049	-	38.345	-
	3	-	Arc	-	0+049	0+124	127.000	74.822	Left
	4	-	-	Transition	0+124	0+180	-	56.000	-
	5	Straight	-	-	0+180	0+308	-	127.894	-

3.5 Vertical Design

3.5.1 Mainline

Mainline Section 1 – R336 to Ballymoneen

The design of the N6 single carriageway vertical alignment from the R336 to Ballymoneen has been developed using appropriate geometric standards applicable to a design speed of 85km/h and the road cross-sections as detailed in **Section 3.2.3** above. **Table 3.14** below provides a list of the geometric elements in the Design, which can be summarised as follows:

- Total number of elements = 23
- No. of straight elements = 12
- No. of crest curves = 6
- No. of sag curves = 5
- Minimum crest curve radius = 5500m
- Minimum sag curve radius = 2600m
- Maximum crest curve radius = 10000m
- Maximum sag curve radius = 12500m
- No. of curves below desirable minimum (below 5500m for crest curves at 85km/h & below 2600m for sag curves at 85km/h) = 0
- Maximum gradient = 5.0%
- Minimum gradient = 1.0%

Table 3.14: Vertical Design Elements – Mainline Section 1

No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
1	Straight	-	-	0+031	0+065	34.293	-	2	2
2	-	-	Sag	0+065	0+158	92.5	3700	2	4.5
3	Straight	-	-	0+158	0+533	375.163	-	4.5	4.5
4	-	Crest	-	0+533	0+675	142.023	5500	4.5	1.918
5	Straight	-	-	0+675	1+813	1138.029	-	1.918	1.918
6	-	Crest	-	1+813	2+039	226.485	5500	1.918	-2.2
7	Straight	-	-	2+039	2+514	474.382	-	-2.2	-2.2
8	-	-	Sag	2+514	2+601	87.518	12500	-2.2	-1.5
9	Straight	-	-	2+601	2+797	195.556	-	-1.5	-1.5
10	Straight	-	-	2+800	2+923	123.38	-	-1	-1
11	-	Crest	-	2+923	3+226	302.37	10000	-1	-3.88
12	-	-	Sag	3+226	3+330	104.48	3700	-3.88	-1.48
13	Straight	-	-	3+330	4+021	690.71	-	-1.48	-1.2
14	-	-	Sag	4+021	4+182	161.20	2600	-1.2	4.58
15	Straight	-	-	4+182	4+261	79.03	-	4.58	5
16	-	Crest	-	4+261	4+426	165.00	5500	5	2.2
17	Straight	-	-	4+426	4+456	30.22	-	2.2	2
18	Straight	-	-	4+460	4+576	116.10	-	2	2.02
19	-	-	Sag	4+576	4+657	80.51	5500	2.02	3.23
20	-	Crest	-	4+657	4+803	146.38	10000	3.23	2.08
21	Straight	-	-	4+803	5+286	483.21	-	2.08	2

No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
22	-	Crest	-	5+286	5+386	100.00	10000	2	1.11
23	Straight	-	-	5+386	5+645	258.62	-	1.11	1

Mainline Section 2 – Ballymoneen to N6/M6 Coolagh

The design of the vertical alignment has been developed using appropriate geometric standards applicable to a design speed of 100km/h and the road cross-sections as detailed in **Section 3.2.3** above. **Table 3.15** below provides a list of the geometric elements in the Design, which can be summarised as follows:

- Total number of elements = 29
- No. of straight elements = 9
- No. of crest curves = 9
- No. of sag curves = 11
- Minimum crest curve radius = 10000m
- Minimum sag curve radius = 5000m
- Maximum crest curve radius = 70000m
- Maximum sag curve radius = 14250m
- No. of curves below desirable minimum (below 10000m for crest curves at 85km/h & below 3700m for sag curves at 100km/h) = 0
- Maximum gradient = 4.0%
- Minimum gradient = -0.13%

Table 3.15: Vertical Design Elements - Section 2

No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
1	-	Crest	-	5+640	5+813	172.934	10000	1	-0.91
2	-	-	Sag	5+813	6+070	257.391	6000	-0.91	2.30
3	-	Crest	-	6+070	6+518	447.882	12000	2.30	-1.11
4	Straight	-	-	6+518	6+758	239.508	-	-1.11	-1.18
5	-	-	Sag	6+758	7+009	251.353	5500	-1.18	3.15
6	-	Crest	-	7+009	7+896	886.717	12000	-0.5	3.93
7	Straight	-	-	7+896	8+575	678.887	-	3.93	-4.0
8	-	-	Sag	8+575	8+779	203.998	6800	-4.0	-1.13
9	Straight	-	-	8+779	9+418	638.836	-	-1.13	-1
10	-	-	Sag	9+418	9+871	453.862	12000	-1	2.68
11	-	Crest	-	9+871	10+550	678.300	10000	2.68	-3.88
12	Straight	-	-	10+550	10+657	106.904	-	-3.88	-3.99
13	-	-	Sag	10+657	10+898	240.964	5000	-3.99	0.65
14	Straight	-	-	10+898	11+434	536.745	-	0.65	0.83
15	-	-	Sag	11+434	11+658	223.503	8000	0.83	3.50
16	-	Crest	-	11+658	12+094	436.222	10000	3.50	-0.65
17	Straight	-	-	12+094	12+875	780.666	-	-0.65	-0.74
18	-	-	Sag	12+875	13+089	214.500	13000	-0.74	0.80
19	Straight	-	-	13+089	13+536	446.820	-	0.80	0.90
20	-	Crest	-	13+536	13+745	208.570	12000	0.90	-0.72
21	-	-	Sag	13+745	14+011	266.095	5500	-0.72	3.78
22	Straight	-	-	14+011	14+254	243.055	-	3.78	3.99

No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
23	-	Crest	-	14+254	14+847	593.716	10000	3.99	-1.80
24	-	-	Sag	14+847	15+024	176.295	14250	-1.80	-0.80
25	Straight	-	-	15+024	15+184	159.891	-	-0.80	-0.69
26	-	-	Sag	15+184	15+397	213.781	6000	-0.69	2.70
27	-	Crest	-	15+397	16+205	807.162	11760	2.70	-3.89
28	-	-	Sag	16+205	16+641	436.689	11000	-3.89	-0.13
29	-	Crest	-	16+641	17+540	899.200	70000	-0.13	-1.30

3.5.2 Link Roads

The design of the vertical alignment has been developed using appropriate geometric standards applicable to a design speed of 60km/h and the road cross-sections as detailed in **Section 3.2.4** above.

3.5.2.1 N59 Link Road

Table 3.16 below provides a list of the geometric elements in the Design, which can be summarised as follows:

- Total number of elements = 15
- No. of straight elements = 8
- No. of crest curves = 3
- No. of sag curves = 4
- Minimum crest curve radius = 1700m
- Minimum sag curve radius = 1300m
- Maximum crest curve radius = 3000m
- Maximum sag curve radius = 2600m

- No. of curves below desirable minimum (below 1700m for crest curves at 60km/h & below 1300m for sag curves at 100km/h) = 0
- Maximum gradient = 6.0%
- Minimum gradient = 1.0%

Table 3.16: Vertical Design Elements – N59 Link Road

No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
1	Straight	-	-	0+000	0+050	49.671	-	2.0	2.0
2	-	-	Sag	0+050	0+154	104.000	2600	2.0	6.0
3	Straight	-	-	0+154	0+432	278.081	-	6.0	6.0
4	-	Crest	-	0+432	0+673	241.170	3000	6.0	-2.039
5	Straight	-	-	0+673	1+164	491.282	-	-2.039	-2.039
6	-	Crest	-	1+164	1+215	50.337	1700	-2.039	-5.0
7	Straight	-	-	1+215	1+349	134.475	-	-5.0	-5.0
8	-	-	Sag	1+349	1+388	39.000	1300	-5.0	-2.0
9	Straight	-	-	1+388	1+547	158.920	-	-2.0	-2.0
10	-	Crest	-	1+547	1+598	51.000	1700	-2.0	-5.0
11	Straight	-	-	1+598	1+708	109.804	-	-5.0	-5.0
12	-	-	Sag	1+708	1+760	52.000	1300	-5.0	-1.0
13	Straight	-	-	1+760	2+088	328.549	-	-1.0	-1.0
14	-	-	Sag	2+088	2+127	39.000	1300	-1.0	2.0
15	Straight	-	-	2+127	2+227	100.022	-	2.0	2.0

3.5.2.2 Parkmore Link Road

Table 3.17 below provides a list of the geometric elements in the Design of the Parkmore Link Road, which can be summarised as follows:

- Total number of elements = 10
- No. of straight elements = 4
- No. of crest curves = 4
- No. of sag curves = 2
- Minimum crest curve radius = 3000m
- Minimum sag curve radius = 3500m
- Maximum crest curve radius = 5500m
- Maximum sag curve radius = 5500m
- No. of curves below desirable minimum (below 1700m for crest curves at 60km/h & below 1300m for sag curves at 100km/h) = 0
- Maximum gradient = 4.67%
- Minimum gradient = 0.52%

Table 3.17: Vertical Design Elements – Parkmore Link Road

No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
1	Straight	-	-	0+000	0+034	33.508	-	0.564	0.564
2	-	Crest	-	0+034	0+099	65.251	3700	0.564	-1.2
3	Straight	-	-	0+099	0+482	383.087	-	-1.2	-1.2
4	-	Crest	-	0+482	0+586	104.218	3000	-1.2	-4.674
5	-	-	Sag	0+586	0+759	172.917	5500	-4.674	-1.53
6	Straight	-	-	0+759	1+057	297.732	-	-1.53	-1.53

No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
7	-	-	Sag	1+057	1+176	118.903	3500	-1.53	1.867
8	-	Crest	-	1+176	1+245	69.698	5500	1.867	0.6
9	Straight	-	-	1+245	1+409	164.015	-	0.6	0.6
10	-	Crest	-	1+409	1+471	61.725	5500	0.6	-0.522

3.5.3 Slip Roads

The design of the vertical alignment has been developed using appropriate geometric standards applicable to a design speed of 60km/h and the road cross-sections as detailed in **Section 3.2.5** above.

3.5.3.1 N59 Letteragh Junction

Table 3.18 below provides a list of the geometric elements in the Design of the N59 Letteragh Junction Slip Roads.

Table 3.18: Vertical Design Elements – Letteragh Junction Slip Roads

	No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
East Bound Diverge	1	-	Crest	-	0+000	0+142	141.937	12000	1.464	0.281
	2	-	Crest	-	0+142	0+267	125.459	2000	0.281	-5.991
	3	-	-	Sag	0+267	0+337	69.829	2000	-5.991	-2.5
	4	Straight	-	-	0+337	0+367	30.126	-	-2.5	-2.5
East Bound Merge	1	Straight	-	-	0+000	0+228	228.228	-	-1.0	-1.0
	2	-	Crest	-	0+228	0+528	300.000	10000	-1.0	-4.0
	3	Straight	-	-	0+528	0+541	13.268	-	-4.0	-4.0
West Bound Diverge	1	Straight	-	-	0+000	0+110	110.065	-	4.0	4.0
	2	-	Crest	-	0+110	0+440	329.992	5500	4.0	-2.0
	3	Straight	-	-	0+440	0+495	55.056	-	-2.0	-2.0
West Bound Merge	1	Straight	-	-	0+000	0+036	36.216	-	2.5	2.5
	2	-	-	Sag	0+036	0+077	40.891	1300	2.5	5.645
	3	-	Crest	-	0+077	0+383	305.818	4000	5.645	-2.0
	4	Straight	-	-	0+383	0+409	25.884	-	-2.0	-2.0

3.5.3.2 N84 Headford Road Junction

Table 3.19 below provides a list of the geometric elements in the Design of the N84 Headford Road Junction Slip Roads.

Table 3.19: Vertical Design Elements – N84 Headford Road Junction Slip Roads

	No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
East Bound Diverge	1	Straight	-	-	0+000	0+012	12.081	-	3.292	3.292
	2	-	Crest	-	0+012	0+127	127.463	10000	3.292	2.138
	3	-	Crest	-	0+127	0+313	312.982	4000	2.138	-2.5
	4	Straight	-	-	0+313	0+508	508.362	-	-2.5	-2.5
East Bound Merge	1	Straight	-	-	0+000	0+153	153.086	-	2.0	2.0
	2	-	Crest	-	0+153	0+373	219.967	8500	2.0	-0.588
	3	Straight	-	-	0+373	0+375	1.996	-	-0.588	-0.588
West Bound Diverge	1	Straight	-	-	0+000	0+001	1.118	-	0.579	0.579
	2	-	Crest	-	0+001	0+165	164.129	10000	0.579	-1.063
	3	-	Crest	-	0+165	0+295	129.342	4000	-1.063	-4.296
	4	-	-	Sag	0+295	0+325	30.538	1700	-4.296	-2.5
	5	Straight	-	-	0+325	0+362	36.470	-	-2.5	-2.5
West Bound Merge	1	Straight	-	-	0+000	0+193	193.066	-	2.0	2.0
	2	-	Crest	-	0+193	0+449	256.110	5000	2.0	-3.122
	3	Straight	-	-	0+449	0+450	0.938	-	-3.122	-3.122

3.5.3.3 N83 Tuam Road/Parkmore Link Road Junction

Table 3.20 below provides a list of the geometric elements in the Design of the N83 Tuam Road/Parkmore Link Road Junction Slip Roads.

Table 3.20: Vertical Design Elements – N83 Tuam Road/Parkmore Link Road Junction Slip Roads

	No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
East Bound Diverge	1	Straight	-	-	0+000	0+010	10.015	-	0.659	0.659
	2	-	Crest	-	0+010	0+154	144.075	10000	0.659	-0.781
	3	-	Crest	-	0+154	0+379	224.569	5500	-0.781	-4.864
	4	-	-	Sag	0+379	0+426	47.288	2000	-4.864	-2.5
	5	Straight	-	-	0+426	0+475	48.737	-	-2.5	-2.5
East Bound Merge	1	Straight	-	-	0+000	0+086	86.167	-	-2.5	-2.5
	2	-	Crest	-	0+086	0+161	75.000	3000	-2.5	-5
	3	Straight	-	-	0+161	0+284	122.672	-	-5	-5
	4	-	-	Sag	0+284	0+428	144.328	2000	-5	2.216
	5	Straight	-	-	0+428	0+469	41.188	-	2.216	2.216
West Bound Diverge	1	Straight	-	-	0+000	0+082	82.107	-	-2.848	-2.848
	2	-	-	Sag	0+082	0+150	68.373	3700	-2.848	-1
	3	Straight	-	-	0+150	0+187	36.107	-	-1.0	-1.0
	4	-	-	Sag	0+187	0+381	193.934	3000	-1.0	5.464
	5	-	Crest	-	0+381	0+469	88.934	3000	5.464	2.5
	6	Straight	-	-	0+469	0+510	40.999	-	2.5	2.5
	1	Straight	-	-	0+000	0+074	74.114	-	2.5	2.5

	No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
West Bound Merge	2	-	-	Sag	0+074	0+152	77.409	5300	2.5	3.961
	3	-	Crest	-	0+1652	0+339	187.212	4000	3.961	-0.720
	4	Straight	-	-	0+339	0+355	16.113	-	-0.720	-0.720

3.5.3.4 N6 Coolagh Junction

Table 3.21 below provides a list of the geometric elements in the Design of the N6 Coolagh Junction Slip Roads.

Table 3.21: Vertical Design Elements – N6 Coolagh Junction Slip Roads

	No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
East Bound Diverge	1	Straight	-	-	0+000	0+090	90.044	-	-3.548	-3.548
	2	-	-	Sag	0+090	0+154	63.676	1300	-3.548	1.350
	3	Straight	-	-	0+154	0+310	156.742	-	1.350	1.350
	4	-	Crest	-	0+310	0+421	110.228	1700	1.350	-5.134
	5	-	-	Sag	0+421	0+513	91.929	1300	-5.134	1.938
East Bound Merge	1	Straight	-	-	0+000	0+009	8.862	-	-0.05	-0.05
	2	-	Crest	-	0+009	0+065	56.112	10000	-0.05	-0.611
	3	-	-	Sag	0+065	0+126	60.576	4000	-0.611	0.904
	4	-	Crest	-	0+126	0+433	307.548	5500	0.904	-4.688
	5	-	-	Sag	0+433	0+629	195.427	5000	-4.688	-0.78
	6	Straight	-	-	0+629	0+673	44.239	-	-0.78	-0.78
	1	Straight	-	-	0+024	0+051	27.505	-	0.93	0.93

	No.	Element Type			Start Chainage	End Chainage	Length (m)	Vertical Radius (m)	Gradient Start	Gradient End
West Bound Diverge	2	-	-	Sag	0+051	0+139	88.094	2000	0.93	5.335
	3	-	Crest	-	0+139	0+309	169.219	3500	5.335	0.5
	4	Straight	-	-	0+309	0+357	47.906	-	0.5	0.5
	5	-	Crest	-	0+357	0+497	140.000	14000	0.5	-0.5
	6	Straight	-	-	0+497	0+607	110.739	-	-0.5	-0.5
	7	-	Crest	-	0+607	0+682	74.900	17500	-0.5	-0.928
	8	Straight	-	-	0+682	0+874	191.918	-	-0.928	-0.928
	9	-	-	Sag	0+874	0+992	117.636	3700	-0.928	2.251
	10	-	Crest	-	0+992	1+213	221.723	16816.426	2.251	0.933
West Bound Merge	1	-	-	Sag	0+000	0+061	60.501	1300	-2.132	2.522
	2	-	Crest	-	0+061	0+165	104.297	1700	2.522	-3.613
	3	-	-	Sag	0+165	0+237	72.651	1300	-3.613	1.976
	4	-	Crest	-	0+237	0+308	70.371	6311.373	1.976	3.091

3.6 Stopping Sight Distance

Full stopping sight distance (SSD) is provided for all mainline, link and slip roads in compliance with TII DN-GEO-03031. An assessment of SSD at diverge and merge locations at grade separated junctions was completed in accordance with TII DN-GEO-03060 Figure 7.19A and 7.19B.

3.6.1 Mainline

The specific stopping sight distance requirements taken from TII DN-GEO-03031 Table 1.3 used for the Design of the proposed road development Mainline Section 1 with a design speed of 85km/h are:

- Desirable Minimum Stopping Sight Distance = 160m
- One Step below Desirable Minimum Stopping Sight Distance = 120m
- Two Steps below Desirable Minimum Stopping Sight Distance = 90m

The specific stopping sight distance requirements taken from TII DN-GEO-03031 Table 1.3 used for the Design of the proposed road development Mainline Section 2 with a design speed of 100km/h are:

- Desirable Minimum Stopping Sight Distance = 215m
- One Step below Desirable Minimum Stopping Sight Distance = 160m
- Two Steps below Desirable Minimum Stopping Sight Distance = 120m

3.6.2 Slip & Link Roads

The specific stopping sight distance requirements taken from TII DN-GEO-03031 Table 1.3 used for the Design of the proposed road development with a design speed of 60km/h are:

- Desirable Minimum Stopping Sight Distance = 90m
- One Step below Desirable Minimum Stopping Sight Distance = 70m
- Two Steps below Desirable Minimum Stopping Sight Distance = 50m

3.7 Full Overtaking Sight Distance

As detailed in **Section 3.1.1,** the road cross-section proposed for the N6 from R336 to Ballymoneen is a Type 1 Single Carriageway (S2).

In accordance with TII Publication DN-GEO-03031, this section of single carriageway has been designed to provide full overtaking sight distance (FOSD) where possible and minimise the length of dubious overtaking conditions.

The minimum FOSD requirement taken from DN-GEO-03031 Table 1/3 used for the Design of the proposed road development Mainline Section 1 from R336 to Ballymoneen with a design speed of 85km/h is 490m.

Climbing lanes are provided at two locations in accordance with DN-GEO-03031 to improve capacity and safety because of the presence of a steep gradient; this climbing lane also provides passing opportunity.

Overtaking sections are provided in the following locations:

- Eastbound – Ch. 0+030 to Ch. 0+860
    - Terminated due to reduction in sight distance to FOSD/4 prior to the centre of the finishing taper of climbing lane. as per DN-GEO-03031 Figure 7/2
- Eastbound – Ch. 4+790 to Ch. 5+390
    - Terminated due to the reduction of sight distance to FOSD/4 on the approach to an at grade junction, as per DN-GEO-03031 Figure 7/4
- Westbound – Ch. 0+2770 to Ch. 0+1850
    - Terminated due to reduction in sight distance to FOSD/4 prior to the centre of the finishing taper of climbing lane. as per DN-GEO-03031 Figure 7/2

The above FOSD lengths total to:

- Eastbound – 25.4% over the entire length of 5600m
- Westbound – 16.4% over the entire length of 5600m

As per Table 7.3 of TII Publication DN-GEO-03031 the requirement of an overtaking value of 50% or greater for new single carriageway sections greater than 2km is not met with the proposed alignment.

The proposed road development transverses and travels adjacent to areas of significant environmental constraints, such as ecologically sensitive areas (SAC, NHA) and also transverses significant human habitat namely existing residential homes and existing communities. The proposed alignment of single carriageway alignment seeks to lessen the impacts on this receiving environment. As a result, the single carriageway alignment incorporates horizontal curvature which limits overtaking opportunities.

Climbing lanes have been included per the requirements of Section 5.3 of DN-GEO-03031. These climbing lanes provide safe and designated overtaking opportunities and contribute to achieving overtaking values of 25.4% eastbound and 16.4% westbound. A departure from the 50% overtaking value standard in DN-GEO-03031 has been approved for the single carriageway.

3.8 Relaxation and Departures

As detailed in **Section 3.1** the Design has been completed in accordance with the Transport Ireland Infrastructure (TII) current design publication standards. TII Publications give the Designer the opportunity to relax the standards within given boundaries. Refer to Drawings **GCOB-100-DP-100** to **111** in **Volume 2** for more information on locations of relaxation and departures. **Appendix A.3.1** contains the record of the departures approval.

Table 3.22 summarises all relaxations that have been incorporated into the Design of the mainline alignment.

Table 3.22: List of Relaxations

Type	Relaxation Ref.	Location	Design Speed	Relaxation Element	Start Ch.	End Ch.
HWY	GCOB-REL-AL-006	N59 Area	100km/h	Vertical Alignment, relaxation in grade from 3% to 4%.	7+900	8+580
HWY	GCOB-REL-AL-008	Menlough	100km/h	Vertical Alignment, relaxation in grade from 3% to 4%.	10+540	10+640
HWY	GCOB-REL-AL-009	N83 Area	100km/h	Vertical Alignment relaxation in grade from 3% to 4%.	14+010	14+250

The following departures, as set out below in **Table 3.23** have been incorporated in the Design. These departures have been submitted to TII for assessment and have obtained approval.

Table 3.23: List of Departures

Departure Ref.	Location	Design Speed	Departure Element	Start Ch.	End Ch.	TII Reference
GCOB-DEP-AL-004	Racecourse Tunnel Area	100km/h	Vertical Alignment, absolute minimum vertical curve length of 200m not achieved. Curve length of 160m provided	14+840	15+020	11166
GCOB-DEP-AL-005	Lackagh Tunnel Area	100km/h	Reduced cross-section	11+150	11+420	11167
GCOB-DEP-AL-006	Racecourse Tunnel Area	100km/h	Reduced cross-section	14+950	15+190	11168
GCOB-DEP-AL-009	River Corrib Area	100km/h	Reduced cross-section	8+850	9+500	11171
GCOB-DEP-AL-010	Menlough Area	100km/h	Reduced cross-section	10+110	10+430	11172
GCOB-DEP-AL-011	N84 Grade Separated Junction	100km/h	Auxiliary Lane Length Reduction	11+430	11+590	11173

Departure Ref.	Location	Design Speed	Departure Element	Start Ch.	End Ch.	TII Reference
GCOB-DEP-AL-012	Overtaking Value Eastbound	85km/h	Overtaking Value Reduction	0+000	5+640	11174
GCOB-DEP-AL-014	Lackagh Tunnel Area	100km/h	Non Standard Diverge	10+600	10+700	11176
GCOB-DEP-AL-015	Lackagh Tunnel Area	100km/h	Non Standard Diverge	11+480	11+580	11177
GCOB-DEP-AL-016	Racecourse Tunnel Area	100km/h	Non Standard Diverge	14+775	14+885	11178
GCOB-DEP-AL-017	Racecourse Tunnel Area	100km/h	Non Standard Diverge	15+460	15+550	11179
GCOB-DEP-AL-018	Racecourse Tunnel Area	100km/h	Emergency crossing points on the central reserve	14+940	15+210	11316
GCOB-DEP-AL-019	Lackagh Tunnel Area	100km/h	Emergency crossing points on the central reserve	11+140	11+430	11317
GCOB-DEP-AL-020	Single Carriageway	85km/h	Horizontal Curve Design	2+800	3+800	11400
GCOB-DEP-AL-021	Single Carriageway	85km/h	Horizontal Curve Design	4+550	5+000	11401
GCOB-DEP-AL-022	Single Carriageway	85km/h	Horizontal Curve Design	5+200	5+640	11402
GCOB-DEP-AL-023	Varies – Locations where the water film depth exceeds that stipulated within DN-GEO-03057	100km/h	Maximum Water Film Depth	-	-	11321
GCOB-DEP-AL-024	Menlough Area	100km/h	Rolling Crown	10+950	10+950	11421
GCOB-DEP-AL-025	N84 Grade Separated Junction	100km/h	Non Standard Merge	12+570	12+870	11423
GCOB-DEP-AL-026	N83 Grade Separated Junction	100km/h	Non Standard Merge	13+150	13+450	11424

Departure Ref.	Location	Design Speed	Departure Element	Start Ch.	End Ch.	TII Reference
GCOB-DEP-DRA-001	River Corrib	100km/h	Runoff Restriction and Attenuation Storage	8+600	10+150	11406,

3.9 Side Roads, Roundabouts

The proposed road development mainline is connected with the existing online network through a series of grade separated junctions, link roads, at grade junctions and roundabouts. The existing local network in the vicinity of the proposed road development is maintained where possible through a series of access and accommodation roads.

3.9.1 Roundabouts

There are two proposed roundabouts in the proposed road development both of which are located on the Type 1 Single Carriageway west of Ballymoneen Road. They range in size from 45m to 60m Inscribed Circle Diameter (ICD) and are designed in accordance with DN-GEO-03060.

These include:

- Bearna West Roundabout at the R336 in Baile Nua
- Bearna East Roundabout at the Bearna to Moycullen Road L1321 in Troscaigh Thoir

3.9.2 Side Roads

All side roads have been designed in accordance with the standards noted in **Section 3.1**. **Table 3.24** details side roads both online and offline

Table 3.24: Side Roads

Road Name	Lane Width	Design Speed (km/h)	Length	Approx. Chainage	Comment
R336 Coast Road West	2 x 3m	60	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	60	90m	Ch. 0+030	Realignment of R336 Coast Road east to proposed roundabout, Bearna West Roundabout, at Baile Nua

Road Name	Lane Width	Design Speed (km/h)	Length	Approx. Chainage	Comment
Na Foraí Maola to Troscaigh Link Road North	2 x 3m	50	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	50	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	50	200m	Ch. 0+190	Link road connecting Na Foraí Maola to Troscaigh Link Road North and Na Foraí Maola to Troscaigh Link Road South
L1321 Bearna to Moycullen Road North	2 x 3m	60	170m	Ch. 2+800	Realignment and tie into proposed Bearna East Roundabout
L1321 Bearna to Moycullen Road South	2 x 3m	60	170m	Ch. 2+800	Realignment and tie into proposed Bearna East Roundabout
L5384 Aille Road	2 x 3m	50	270m	Ch. 3+310	Realignment of L5384 Aille Road for proposed mainline overbridge
Cappagh Road North	2 x 3m	50	140m	Ch. 4+450	Realignment and tie into proposed signalised junction
Cappagh Road South	2 x 3m	50	230m	Ch. 4+450	Realignment and tie into proposed signalised junction
Ballymoneen Road North	2 x 3m	50	230m	Ch. 5+650	Realignment and tie into proposed signalised junction
Ballymoneen Road South	2 x 3m	50	130m	Ch. 5+650	Realignment and tie into proposed signalised junction
Rahoon Road	2 x 3m	50	290m	Ch. 6+350	Redesign of Rahoon Road at

Road Name	Lane Width	Design Speed (km/h)	Length	Approx. Chainage	Comment
					Mincloon to accommodate mainline underbridge
Clybaun Road	2 x 3m	50	410m	Ch. 6+350 to Ch. 6+650	Redesign of Clybaun Road at Mincloon to accommodate mainline underbridge and staggered junction
Rahoon Road	2 x 3m	50	290	N59 Link Road Ch. 2+200	Redesign Rahoon Road at Gort na Bró to tie to proposed signalised junction with Letteragh Link Road South
Gort na Bró Road	2 x 3m	50	270m	N59 Link Road Ch. 2+200	Redesign of Gort na Bró Road to tie to proposed signalised junction with Rahoon Road (Rahoon Road Junction) and N59 LRS+
Letteragh Road	2 x 3m	50	780m	Ch. 7+250	Redesign of Letteragh Road to tie into proposed signalised junction with Letteragh Link Road South and proposed mainline underbridge
Moycullen Road N59	2 x 3.5m	50	350m	N59 LRN* Ch. 0+000	Redesign of N59 Moycullen Road at Bushypark to tie in to proposed signalised junction with Letteragh Road North
Moycullen Road N59	2 x 3.5m	50	390m	Ch. 8+500	Redesign of N59 Moycullen Road at Dangan to accommodate proposed mainline underbridge
Bóthar Nua	2 x 3m	50	260m	Ch. 10+110	Redesign of Bóthar Nua at

Road Name	Lane Width	Design Speed (km/h)	Length	Approx. Chainage	Comment
					Coolough to accommodate proposed mainline underbridge
Sean Bóthar	2 x 3m	50	250m	Ch. 10+475	Realignment and tie into existing
Headford Road N84	2 x 3.5 lanes transitioning to 4 x 3.5m	50	400m	Ch. 12+125	Redesign of N84 Headford Road to accommodate proposed grade separated junction
School Road L2134	2 x 3m	50	240m	Ch. 13+150	Redesign of L-2134 School Road, Castlegar to accommodate proposed mainline overbridge
Tuam Road N83	2 x 3.5 lanes transitioning to 4 x 3.5m 1x3.25m Bus Lane	50	1060m	Ch. 14+000	Redesign of N83 Tuam Road to accommodate proposed grade separated junction
N6 Bóthar na dTreabh at City East Business Park	4 x 3.5m lanes	50	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	50	190m	Ch. 15+730	Redesign of Briarhill Business park road to accommodate proposed mainline underbridge
Monivea Road R339	2 x 3.5m	50	275m	Ch. 15+850	Redesign of Monivea Road R339 to accommodate proposed mainline underbridge
Ballybrit Crescent	2 x 3.5m	50	200m	Ch. 15+850	Redesign of Ballybrit Crescent Road

3.9.3 Access/Accommodation Roads

There are 87 access roads in total as part of the proposed road development. 46 access roads west of the River Corrib and 41 access roads east of the River Corrib. There are 8 access roads designed solely for drainage pond maintenance. Further details of each access road are available in **Chapter 11, Accommodation Works & Land Use**.

All access roads have been designed according to their purpose e.g. farm and drainage pond access roads have been designed to CC-SCD-00706 with 4m lane width and 1m verge width either side.

Passing bays have been included every 250m where applicable. Where access roads are serving more than one house or business, 2 x 3m lane width is provided to accommodate two-way traffic with a 1m wide verge either side.

3.9.4 Design Speed

3.9.4.1 Side Roads

In general side roads have been designed to 50km/h as they are largely located in the Immediate Approach to a Junction (IAJ) or within an urban environment. See **Table 3.24** above.

3.9.5 Relaxation and Departures

A summary of side road relaxations and departures are listed in **Table 3.25** and

Table 3.26 respectively. Refer to Drawings **GCOB-100-DP-200** to **221** in **Volume 2** for location details.

Table 3.25: Side Road Relaxations

Relaxation Ref.	**Location**	**Design Speed**	**Relaxation Element**	**Start Ch.**	**End Ch.**
REL-SR-AL-001	R336 West Approach	60km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2m utilised on lightly used access. Full 'y' distance provided	0+010	0+010
REL-SR-AL-002	R336 West Approach	60km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided.	0+010	0+010
REL-SR-AL-003	R336 East Approach	60km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2m utilised on lightly used access. Full 'y' distance provided	0+010	0+010
REL-SR-AL-004	Foraí Maola to Troscaigh Link - South	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+010	0+010

Relaxation Ref.	Location	Design Speed	Relaxation Element	Start Ch.	End Ch.
REL-SR-AL-005	Foraí Maola to Troscaigh Link - South	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2m utilised on lightly used access. Full 'y' distance provided	0+060	0+060
REL-SR-AL-006	Foraí Maola to Troscaigh Link - South	50km/h	DN-GEO-03031 (TD9) Horizontal Alignment: Three steps below desirable minimum horizontal radius provided (R=65m)	0+150	0+190
REL-SR-AL-007	Foraí Maola to Troscaigh Link - South	50km/h	DN-GEO-03031 (TD9) Stopping Sight Distance: One step below desirable minimum stopping sight distance provided (SSD=50m)	0+150	0+190
REL-SR-AL-008	Foraí Maola to Troscaigh Link - South	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2m utilised on lightly used access. Full 'y' distance provided	0+720	0+720
REL-SR-AL-009	Foraí Maola to Troscaigh Link - South	50km/h	DN-GEO-03031 (TD9) Horizontal Alignment: One step below desirable minimum horizontal radius provided (R=127m)	0+510	0+670
REL-SR-AL-010	Foraí Maola to Troscaigh Link - North	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'y' distance of 50m utilised on lightly used access. Full 'x' distance provided	0+190	0+190
REL-SR-AL-011	Foraí Maola to Troscaigh Link - North	50km/h	DN-GEO-03031 (TD9) Horizontal Alignment: Three steps below desirable minimum horizontal radius provided (R=65m)	0+110	0+195
REL-SR-AL-012	Foraí Maola to Troscaigh Link - North	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'y' distance of 50m utilised on lightly used access. Full 'x' distance provided	0+090	0+090
REL-SR-AL-013	Foraí Maola to Troscaigh Link - North	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2m utilised on lightly used access. Full 'y' distance provided	0+040	0+040
REL-SR-AL-014	Aille Road	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+170	0+170

Relaxation Ref.	Location	Design Speed	Relaxation Element	Start Ch.	End Ch.
REL-SR-AL-015	Aille Local Road	50km/h	DN-GEO-03031 (TD9) Horizontal Alignment: Two steps below desirable minimum horizontal radius provided (R=100m)	0+005	0+080
REL-SR-AL-018	Cappagh Road North	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+070	0+070
REL-SR-AL-019	Cappagh Road North	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+085	0+085
REL-SR-AL-020	Cappagh Road South	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+180	0+180
REL-SR-AL-021	Cappagh Road South	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+130	0+130
REL-SR-AL-022	Cappagh Road South	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+130	0+130
REL-SR-AL-023	Cappagh Road South	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+100	0+100
REL-SR-AL-027	Rahoon Road	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2m utilised on lightly used access. Full 'y' distance provided	0+000	0+000
REL-SR-AL-028	Rahoon Road	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2m utilised on lightly used access. Full 'y' distance provided	0+000	0+000
REL-SR-AL-029	Rahoon Road	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2m utilised on lightly used access. Full 'y' distance provided	0+260	0+260

Relaxation Ref.	Location	Design Speed	Relaxation Element	Start Ch.	End Ch.
REL-SR-AL-030	Rahoon Road	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2m utilised on lightly used access. Full 'y' distance provided	0+290	0+290
REL-SR-AL-031	Realigned Clybaun Road	50km/h	DN-GEO-03031 (TD9) Horizontal Alignment: One step below desirable minimum horizontal radius provided (R=165m)	0+150	0+320
REL-SR-AL-032	Realigned Clybaun Road	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2m utilised on lightly used access. Full 'y' distance provided	0+040	0+040
REL-SR-AL-033	Letteragh Road	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+290	0+290
REL-SR-AL-034	Letteragh Road	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+360	0+360
REL-SR-AL-038	N59 Link Road South (Bóthar Diarmuida)	60km/h	DN-GEO-03031 (TD9) Horizontal Alignment: One step below desirable minimum horizontal radius provided (R=150m)	2+100	2+155
REL-SR-AL-039	N59 Link Road South (Bóthar Diarmuida)	60km/h	DN-GEO-03031 (TD9) Horizontal Alignment: Two steps below desirable minimum horizontal radius provided (R=90m)	2+155	2+200
REL-SR-AL-040	Western Distributor Road	60km/h	DN-GEO-03031 (TD9) Horizontal Alignment: One step below desirable minimum horizontal radius provided (R=127m)	0+080	0+170
REL-SR-AL-041	N59 Link Road North	60km/h	DN-GEO-03031 (TD9) Vertical Alignment: One step relaxation to vertical gradient for Type 1 single carriageway road type (G=6%)	0+160	0+440
REL-SR-AL-042	N59	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+020	0+020

Relaxation Ref.	Location	Design Speed	Relaxation Element	Start Ch.	End Ch.
REL-SR-AL-043	N59	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+040	0+040
REL-SR-AL-044	N59	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+080	0+080
REL-SR-AL-045	N59	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+110	0+110
REL-SR-AL-046	N59	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+130	0+130
REL-SR-AL-050	N59	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+185	0+185
REL-SR-AL-051	Circular Road	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	N/A	N/A
REL-SR-AL-052	Bóthar Nua	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.0m utilised on lightly used access. Full 'y' distance provided	0+150	0+150
REL-SR-AL-053	Seanbóthar Menlo	50km/h	DN-GEO-03043 (TD41/42) Dwell Area: Clause 7.17, the gradient for the dwell area shall lie between +/- 2.5%. In difficult situations, this may be relaxed to +/- 4%. (4% utilised)	0+240	0+252
REL-SR-AL-055	N84	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+005	0+005
REL-SR-AL-056	N84	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m	0+055	0+055

Relaxation Ref.	Location	Design Speed	Relaxation Element	Start Ch.	End Ch.
			utilised on lightly used access. Full 'y' distance provided		
REL-SR-AL-057	N84	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+065	0+065
REL-SR-AL-058	N84	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+085	0+085
REL-SR-AL-060	N84	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+095	0+095
REL-SR-AL-062	N84	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+105	0+105
REL-SR-AL-064	School Road	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2m utilised on lightly used access. Full 'y' distance provided	0+200	0+200
REL-SR-AL-069	Ballybrit Crescent	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+175	-
REL-SR-AL-070	Ballybrit Crescent	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+110	-
REL-SR-AL-071	Ballybrit Crescent	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+060	-
REL-SR-AL-072	Monivea Road R339	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+050	-

Relaxation Ref.	Location	Design Speed	Relaxation Element	Start Ch.	End Ch.
REL-SR-AL-073	Monivea Road R339	50km/h	DN-GEO-03043 (TD41/42) Junction Visibility: Local Road, 'x' distance of 2.4m utilised on lightly used access. Full 'y' distance provided	0+095	-
REL-SR-AL-074	Briarhill Business Park Road	50km/h	DN-GEO-03031 (TD9) Vertical Alignment: One step below desirable minimum vertical radius provided (R=650m)	0+090	0+120
REL-SR-AL-075	City East Business Park Road	50km/h	DN-GEO-03031 (TD9) Horizontal Alignment: Two steps below desirable minimum horizontal radius provided (R=110m)	0+030	0+160
REL-SR-AL-076	R446 North from Martin Roundabout	85km/h	DN-GEO-03031 (TD9) Vertical Alignment: One step relaxation to vertical gradient for Motorways and Type 1 Dual Carriageways (G=3.7%)	0+240	0+300
REL-SR-AL-077	Realigned N6 to GCRR	70km/h	Taper reduction to one lane	0+510	0+640
REL-SR-AL-078	Eastbound diverge from realigned N6 to R446 south.	60km/h	DN-GEO-03031 (TD9) Horizontal Alignment: Two steps below desirable minimum horizontal radius provided with superelevation of 5% (R=160m)	0+110	0+300
REL-SR-AL-079	R446 to proposed road development westbound	60km/h	DN-GEO-03031 (TD9) Horizontal Alignment: Two steps below desirable minimum horizontal radius provided with superelevation of 5% (R=127m)	0+050	0+180
REL-SR-AL-080	R446 to proposed road development westbound	60km/h	Taper reduction to one lane	0+040	0+170
REL-SR-AL-081	Bearna Overbridge Link	50km/h	DN-REQ-03034 Cl 7.2. 30m Approach length to Parapet is curved around bend of southern link road due to proximity of junction	0+000	0+020
REL-SR-AL-082	Bearna Overbridge Link	50km/h	DN-REQ-03034 Cl 7.2. 15m Departure length is curved around a bend of southern link road due to proximity of junction	0+000	0+020

Relaxation Ref.	Location	Design Speed	Relaxation Element	Start Ch.	End Ch.
REL-SR-AL-083	Aille Road	50km/h	DN-REQ-03034 Cl 7.2. 15m Departure length is curved around a bend of access road. 10m achieved on Aille Road	0+150	0+170
REL-SR-AL-084	School Road	50km/h	DN-REQ-03034 Cl 7.2. 30m Approach length to Parapet is curved around a bend of access road	0+080	0+080

Table 3.26: Side Road Departures

Departure Ref.	Location	Design Speed	Departure Element	Ch.	TII Reference
DEP-SR-AL-001	R336 West Approach	60km/h	Horizontal Alignment, adverse crossfall	0+000	11217
DEP-SR-AL-002	Mainline Ch. 0+700	85km/h	Horizontal Alignment, maintenance access on overtaking section	0+700	11218
DEP-SR-AL-003	Mainline Ch. 0+990	85km/h	Maintenance access, obstruction to overtaking	0+990	11219
DEP-SR-AL-004	Foraí Maola to Troscaigh Link South	50km/h	Combination Departure, horizontal alignment and forward visibility	0+180	11220
DEP-SR-AL-005	Foraí Maola to Troscaigh Link South	50km/h	Reduced Cross-section width	0+000	11221
DEP-SR-AL-006	Foraí Maola to Troscaigh Link South	50km/h	Horizontal Alignment, adverse crossfall	0+000	11222
DEP-SR-AL-007	Foraí Maola to Troscaigh Link South	50km/h	Reduced Cross-section width	0+710	11223
DEP-SR-AL-008	Foraí Maola to Troscaigh Link South	50km/h	Horizontal Alignment, adverse crossfall	0+710	11224
DEP-SR-AL-009	Foraí Maola to Troscaigh Link North	50km/h	Reduced Cross-section width	0+000	11225
DEP-SR-AL-010	Foraí Maola to Troscaigh Link North	50km/h	Horizontal Alignment, adverse crossfall	0+000	11227
DEP-SR-AL-011	Bearna to Moycullen Road North	60km/h	Reduced Cross-section width	0+000	11228

Departure Ref.	Location	Design Speed	Departure Element	Ch.	TII Reference
DEP-SR-AL-012	Bearna Moycullen Road North	60km/h	Horizontal Alignment, adverse crossfall	0+000	11229
DEP-SR-AL-013	Bearna Moycullen Road South	60km/h	Reduced Cross-section width	0+000	11230
DEP-SR-AL-014	Bearna Moycullen Road South	60km/h	Horizontal Alignment, adverse crossfall	0+000	11231
DEP-SR-AL-015	Bearna Moycullen Road North	60km/h	Access in close proximity to Junction	0+100	11232
DEP-SR-AL-016	Aille Road L5384	50km/h	Reduced Cross-section width	0+250	11233
DEP-SR-AL-017	Aille Road L5384	50km/h	Horizontal Alignment, adverse crossfall	0+250	11234
DEP-SR-AL-018	Aille Road L5384	50km/h	Reduced Cross-section width	0+000	11235
DEP-SR-AL-019	Aille Road	50km/h	Horizontal Alignment, adverse crossfall	0+000	11236
DEP-SR-AL-020	Cappagh Road North	50km/h	Reduced Cross-section width	0+000	11237
DEP-SR-AL-021	Cappagh Road North	50km/h	Horizontal Alignment, adverse crossfall	0+000	11238
DEP-SR-AL-024	Mainline Ch. 4+970	85km/h	Maintenance access, obstruction to overtaking	4+970	11241
DEP-SR-AL-025	Ballymoneen Road South	50km/h	Reduced Cross-section width	0+000	11242
DEP-SR-AL-027	Ballymoneen Road North	50km/h	Reduced Cross-section width	0+000	11244
DEP-SR-AL-028	Rahoon Road	50km/h	Reduced Cross-section width	0+000	11245
DEP-SR-AL-029	Rahoon Road	50km/h	Horizontal Alignment, adverse crossfall	0+260	11246
DEP-SR-AL-030	Rahoon Road	50km/h	Horizontal Alignment, adverse crossfall	0+260	11247
DEP-SR-AL-031	Realigned Clybaun Road	50km/h	Vertical Alignment	0+000	11248
DEP-SR-AL-032	Realigned Clybaun Road	50km/h	Horizontal Alignment, adverse crossfall	0+000	11249
DEP-SR-AL-033	Letteragh Road West	50km/h	Horizontal Alignment, adverse crossfall	0+000	11250
DEP-SR-AL-034	Letteragh Road West	50km/h	Reduced Cross-section width	0+000	11251
DEP-SR-AL-035	Letteragh Road West	50km/h	Vertical Alignment	0+340	11252
DEP-SR-AL-036	Letteragh Road East	50km/h	Horizontal Alignment, adverse crossfall	0+000	11253

Departure Ref.	Location	Design Speed	Departure Element	Ch.	TII Reference
DEP-SR-AL-037	Letteragh Road East	50km/h	Reduced Cross-section width	0+000	11254
DEP-SR-AL-038	N59 Link Road South	60km/h	Crossroads	1+910	11255
DEP-SR-AL-039	Gort na Bró Road	50km/h	Crossroads	0+110	11256
DEP-SR-AL-040	Gort Siar	50km/h	Horizontal Alignment, adverse crossfall	0+000	11257
DEP-SR-AL-042	Bóthar Nua	50km/h	Reduced Cross-section width	0+000	11259
DEP-SR-AL-043	Bóthar Nua	50km/h	Horizontal Alignment, adverse crossfall	0+000	11260
DEP-SR-AL-044	Bóthar Nua	50km/h	Reduced Cross-section width	0+240	11261
DEP-SR-AL-045	Seanbóthar, Menlo	50km/h	Reduced Cross-section width	0+000	11262
DEP-SR-AL-046	Seanbóthar, Menlo	50km/h	Horizontal Alignment, adverse crossfall	0+000	11263
DEP-SR-AL-047	Seanbóthar, Menlo	50km/h	Vertical Alignment	0+000	11264
DEP-SR-AL-048	Seanbóthar, Menlo	50km/h	Vertical Alignment	0+050	11265
DEP-SR-AL-050	N83	50km/h	Horizontal Alignment, adverse crossfall	0+000	11267
DEP-SR-AL-054	Briarhill Business Park Road	50km/h	Horizontal Alignment, adverse crossfall	0+142	11310
DEP-SR-AL-055	Briarhill Business Park Road	50km/h	Horizontal Alignment, adverse crossfall	0+050	11311
DEP-SR-AL-056	Briarhill Business Park Road	50km/h	Horizontal Alignment, adverse crossfall	0+009	11312
DEP-SR-AL-057	Briarhill Business Park Road	50km/h	Horizontal Alignment	0+050	11313
DEP-SR-AL-058	Briarhill Business Park Road	50km/h	Horizontal Alignment	0+142	11314
DEP-SR-AL-059	R446 North from Martin Roundabout	85km/h	Stopping Sight Distance	0+000	11315
DEP-SR-AL-060	School Road, Castlegar	50km/h	Safety Barrier Design - Approach Length	0+200	11399

3.10 Safety Barriers

A preliminary design of vehicle restraint systems has been completed in accordance with DN-REQ-03034 Safety Barriers and DN-STR-03011 (The Design of Vehicle and Pedestrian Parapets). All potential hazards located within the clear zone have been identified and categorised as per hazard definitions, classifications, and rankings referred to in DN-REQ-03034. A preliminary safety barrier schedule has been compiled, refer to **Appendix A.3.2**. Drawings **GCOB-400-D-000** to **015** in **Volume 2** present the plan layout of the preliminary design of safety barriers.

Linear hazards identified include embankment slopes, rock cuts, linear v-channels such as pre-earthwork drainage (PED) and opposite directional traffic. Isolated hazards include proposed drainage ponds, bridge parapets, culvert headwalls, major signage (advance directional and directional signposts), gantry plinths, and bridge piers.

As a safety barrier is in fact a hazard in itself an effort to reduce provision of safety barriers across the proposed road development was completed. This exercise was prompted following recommendation from a road safety audit therefore an effort to achieve a more *'forgiving roadside'* design was completed. Embankment side slopes were flattened from 1:2 to 1:3 across the entire single carriageway section. A portion of the side slopes on the dual carriageway section of the proposed road development was also flattened from 1:2 to 1:3 side slopes (Ch. 5+640 to Ch. 6+100 and Ch. 6+500 to Ch. 7+200).

The proposed safety barrier design has been checked against mainline forward visibility to ensure no obstruction to road user's sightline. All proposed merge and diverge slip roads have also been checked for visibility requirements.

All accommodation tracks and access roads have been cross checked against the proposed safety barrier design and re-aligned where necessary. All transitions between safety barriers types have been identified, including those from bridge parapet to safety barrier and vice versa.

Each barrier has been assigned a containment level, impact severity level, working class, and set-back (taken from the edge of the carriageway under consideration) The preliminary design took cognisance of '*a reasonable compromise between a large working width and a generous set-back'* (clause 5.21 of DN-REQ-03034). Where possible, more economical choices between working width classes were made whilst ensuring safety of the design (maximum working width class has been set at W4 which means that the safety barrier in the event of an impact with a vehicle can, in theory, deform up to 1.3m). A summary of safety barriers types to be provided along the proposed road development is listed in

Table 3.27 below.

As part of the requirements of the Standards, a Risk Assessment Procedure has been undertaken for each item considered as hazardous along all side roads and access roads impacted by the proposed road development. Out of 21 locations assessed, 11 locations have been identified as potentially hazardous and have therefore been designed with safety barriers as a result of the assessment.

Table 3.27: Summary of Safety Barrier

Containment level	Barrier type*	Length (m)
N2	N2/A/W1	7151
	N2/A/W2	747

Containment level	Barrier type*	Length (m)
	N2/A/W4	17461
N1	N1/A/W2	520
	N1/A/W4	9318
H2	H2/A/W1	2434
	H2/A/W2	438
	H2/A/W4	3378
	H2/B/W2	12114**
	Total length all barrier type combined:	53606
* In the form of Containment level / Impact severity level / Working width class (i.e.: N2/A/W1) ** Concrete Central Median Barrier on Dual Carriageway		

3.11 Weave/Merge Assessment

A weaving design assessment between the N84 Headford Road Junction and N83 Tuam Road Junction has been undertaken in accordance with Section 7.9 of DN-GEO-03060. Computing the formula as set out in Section 7.9 a value of N=2 was yielded in both westbound and eastbound directions. Refer to **Appendix A.3.3** for further details.

A provision of three carriageway lanes in each direction has been included in the mainline design between the N84 and N83 with a lane gain and lane drop at the merge and diverge locations. A Type C merge lane layout has been provided at the N84 eastbound & N83 westbound slips as per Figure 7.4.3 DN-GEO-03060. A Type B Single Lane Parallel Diverge showing 2 x 3.0m Diverging Lane Connector Road has been provided at the N84 westbound and N83 eastbound slips as per Figure 7.6.1 DN-GEO-03060.

3.12 Alignment amendments post Emerging Preferred Route Corridor

Since the publication of the Route Selection Report in March 2016 work has continued on the design of the proposed road development. The process of producing the design from a route corridor is an iterative process. Inputs were received from the environmental specialists, public consultations, submissions, stakeholder commentary and from the over 850 individual landowner meetings. The work has focused on minimising impacts to 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 route moving outside the published EPRC. 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 in the sections below.

3.12.1 General

Amendments and enhancements of the design include development of accommodation works via consultation with directly impacted property owners, refinement of local junction and access arrangement, to improve accessibility and performance, and horizontal alignment alterations to minimise impacts to property owners. An overview of the major amendments are outlined in the subsequent sections.

3.12.2 Na Foraí Maola to Ballymoneen Ch. 0+000 to Ch. 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 is provided at the R336 Bearna West Roundabout in Baile Nua and at the Bearna East Roundabout on the L1321 Bearna to Moycullen Road only.

Troscaigh Thoir

In Troscaigh Thoir the proposed mainline alignment moved further north away from residential properties on the Ann Gibbons road. The at-grade roundabout on the L1321 Bearna to Moycullen Road moved further south to reduce impacts on an existing 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 centrepoint of the proposed road development to provide adequate headroom and to reduce the excavation depth in rock cutting along the mainline alignment.

Cappagh

The mainline alignment 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 on residential properties north and south of the proposed road development and also to provide direct access 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.

3.12.3 N59 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 existing 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 Letteragh 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 Letteragh Link Road to going over to reduce overall excavation depths in the rock cutting.

3.12.4 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 length and skew angle of the bridge over the river.

3.12.5 Castlegar Area Ch. 8+300 to Ch. 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.

3.12.6 N83/Parkmore Link Road Junction Ch. 13+600 to Ch. 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 (Font Junction) as the traffic is retained on the proposed road development.
- Frees up road space on the existing N6 between the N6/N83 Tuam Road Junction and the proposed Coolagh Junction.

3.12.7 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 there was minimal demand on this eastern link road.

- Minimises impacts on existing employment centres and potential future employment opportunities.
- 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.

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

A design change to the proposed Galway Racecourse Tunnel was adopted following a peer review with the client, Galway County Council, and 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 provided the following benefits in comparison to the EPRC design:

- 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.
- Significant increase in time available to excavate the rock in the open cut section to the west of the proposed tunnel as it is now not limited to the nine month construction window which was driven by the need to accommodate the racecourse operations.
- 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 proposed design removes the conflict of the eastbound merge and westbound diverge with the western tunnel portal.
- Slip ramps on revised N83 Junction do not require departures 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.

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

Following the Phase 3 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 with an underbridge structure. 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.
- Has reduced construction costs and construction complexity.

4 Junction Strategy

4.1 Introduction

This chapter provides an overview of the junction strategy for the proposed road development. Detail on side roads and interchanges, and their geometric parameters, provided as part of the proposed road development, are outlined within **Chapter 3, Alignment Geometry**.

The capacity of the junctions has been assessed for the Design Year of the proposed road development.

The proposed road development junction layouts are presented on Drawings **GCOB-000-D-000** to **015** in **Volume 2**. The Junction Strategy Report is provided in **Appendix A.4.1** with a summary provided in this chapter.

4.1.1 Proposed Road Development Junction Strategy

The proposed road development connects the existing N6 at Coolagh to the R336 west of Bearna Village. The proposed road development interacts with the existing road network along its length. There are a number of junctions proposed to directly connect the existing networks to the proposed road development mainline, namely:

- Bearna West Roundabout
- Bearna East Roundabout
- Cappagh Road Junction
- Ballymoneen Road Junction
- N59 Letteragh Junction
- N84 Headford Road Junction
- N83 Tuam Road Junction
    - Parkmore Link Road Junction
    - City North Business Park Junction
    - Business Park Junction 1
    - Business Park Junction 2
    - Parkmore Industrial Estate Junction
- Coolagh Junction

Direct access junctions are detailed in **Section 4.2**.

In addition to junctions directly connecting to the proposed road development there are a number of junctions provided, upgraded, connected to, or maintained as part of the proposed road development, namely:

- Na Foraí Maola Junction
- Troscaigh Junction
- Na Foraí Maola Local Junction
- An Chloch Scoilte Junction

- Clybaun Road Junction
- Bóthar Diarmuida Junction
- Gort Na Bró Junction
- Gateway Retail Park Junction
- Rahoon Road Junction
- Letteragh Road Junction
- Bushypark Junction
- Ballybrit Crescent Junction
- Lynch Junction
- City East Business Park Junction

Junctions that do not directly connect to the proposed road development but are provided, upgraded, connected to, or maintained as part of the proposed road development are detailed in **Section 4.3**.

In addition to the junctions noted above, access roads and their associated junctions to the existing and proposed road networks are provided as part of the proposed road development. The accommodation roads are detailed within **Chapter 11, Accommodation Works & Land Use**.

4.1.2 Ratio of Flow to Capacity at Major Junctions

Ratio of Flow to Capacity (RFC) 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.

For the proposed road development, non-signalised junctions have been designed to have a RFC of 85% and less, signalised junctions have been designed to have a RFC of 90% and less.

4.1.3 Junction Configuration

A swept path analysis has been performed for each of the major movements of the proposed road development junctions to ensure that the design vehicle does not encroach onto the opposing or adjacent carriageway, cycle lane, bus lane or pedestrian footway. TII Publication DN-GEO-03060 specifies a 16.5m articulated design vehicle.

4.1.4 TEN-T Network

The proposed road development forms part of the TEN-T Comprehensive Network and is a protected road and motorway scheme.

Direct access to the mainline is restricted to a limited number of junctions. Each junction connecting directly with the proposed road development mainline are noted within **Section 4.1.1** above.

4.1.5 Junction Strategy Objectives

The objectives of the proposed road development junction strategy are based on European regulations such as EU 1315/2013 which sets out the requirements for high quality roads that shall for part of the network both Core and Comprehensive.

TII guidance is also aligned with the strategy objectives outlined above. TII supports a junction strategy which seeks to prevent a proliferation of side road junctions along national roads with speed limits of greater than 60 km/h. The application of this strategy will maintain the capacity, efficiency and safety of the national road network.

A summary of junction strategy objectives includes the following:

- Sufficient junctions to provide a minimum level of accessibility to the region to support further economic, social and territorial development. As the proposed road development is of strategic importance and part of the TEN-T Comprehensive Network access is limited to provide the above as a minimum.
- Provide connectivity to the National and Regional road network.
- Serve existing travel demand.
- Junctions located so as to relieve traffic congestion. Junction form to deliver capacity as experience has shown that the network breaks down due to junction failure caused by capacity problems.
- Promote a mobility that is efficient and safe.

4.1.6 Junction Strategy Summary

As detailed, the proposed road development forms a constituent element of the wider reaching Galway Transport Strategy. The conclusions of the GTS have influenced the junction strategy in so far as the junctions on the proposed road development are located to reflect demand and additional lanes are included at various locations along the existing road network to accommodate bus only lanes, cycle tracks and footpaths.

Detailed analysis of the travel patterns has given an understanding of travel demand in Galway City and its environs. This in turn has informed the junction strategy which matches demand to the siting of junction connectivity.

On the single carriageway section of the proposed road development at-grade junctions are provided per Table 2.1 of TII-DN-GEO-03060 (Geometric Design of Junctions (priority junctions, direct accesses, roundabouts, grade separated and compact grade separated junctions)).

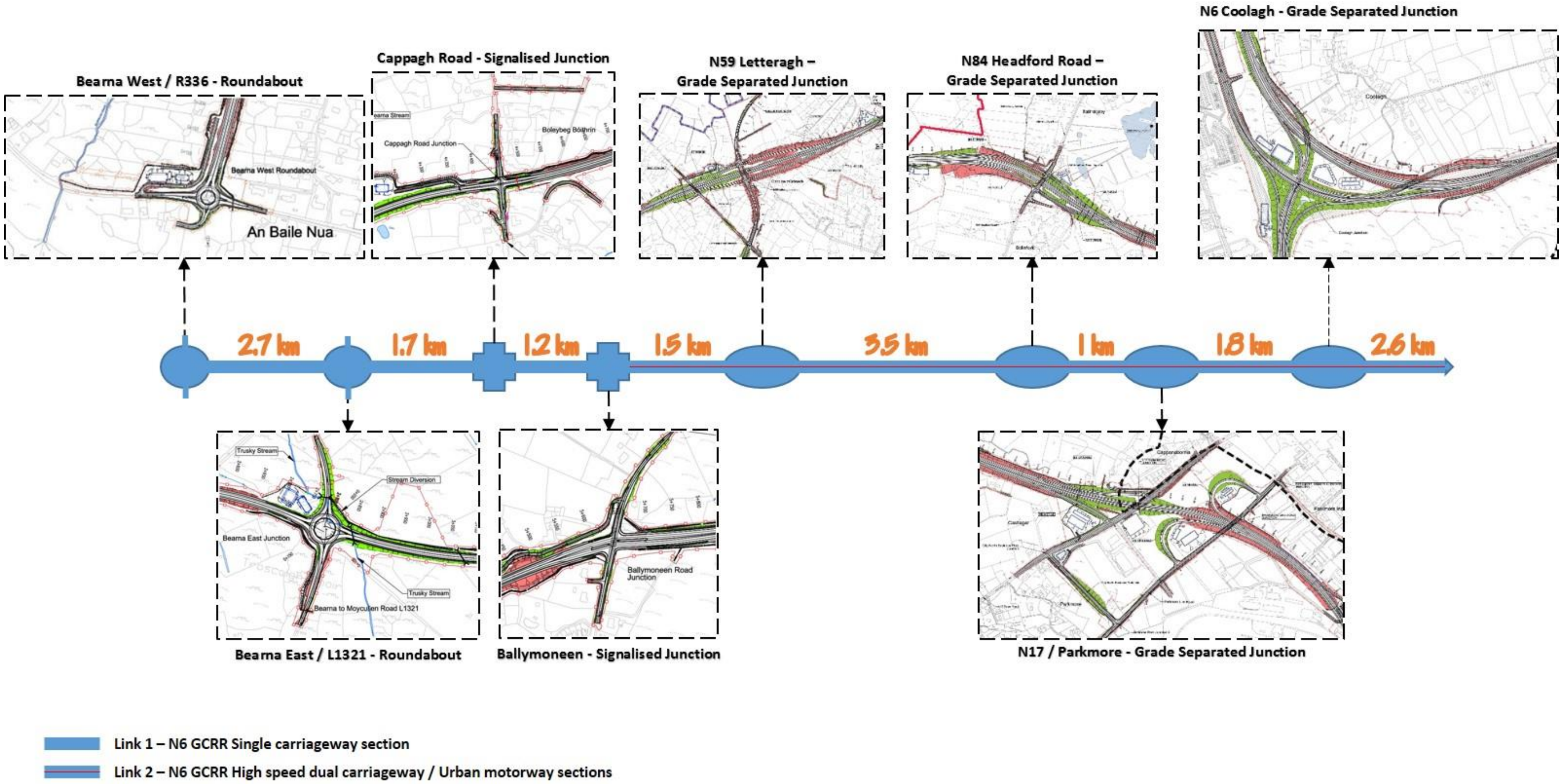
On the dual carriageway section of the proposed road development grade separation was selected due to the large traffic volumes and demand required at its intersections with national roads, i.e. N6, N83, N84 and N59 per section 4.2.1.3 of TII-DN-GEO-03060.

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

4.2 Direct Access Junctions

Figure 4.1: Diagram illustrating all proposed junction types and their location along the proposed road development mainline



4.2.1 Bearna West Roundabout

The R336 is a regional road running along the south coast of County Galway connecting Galway to Bearna Village to Spiddal and onwards to Rossaveel. The proposed road development terminates at the R336 at a ninety-degree angle west of Bearna Village, thus creating a junction in the area. The existing R336 geometry in the vicinity of this proposed junction is of a reasonable standard with a posted speed limit of 60km/h. There are many properties accessing directly onto the R336, and this becomes continuous once the 50km/h zone is encountered, which subsequently leads to Bearna Village.

At the location of the proposed Bearna West Roundabout, the R336 caters for average annual daily traffic (AADT) volumes of approximately 13,000 AADT per day in the 2039 design year. At the proposed junction 11,000 AADT vehicles divert onto the proposed road development mainline and 3,000 AADT continue into Bearna Village on the R336. Approximately 3% of the traffic constitutes Heavy Goods Vehicles (HGV's).

At this junction on the R336 one of the overriding objectives is to reduce speeds in order to inform drivers of a major decision point. Drivers can choose to remain on the existing R336 to enter the 50km/h zone to Bearna Village or choose to divert onto the proposed road development mainline to bypass the village and built-up area. A roundabout is a large physical feature which will successfully inform drivers of the change. The junction can also convey all road users in an efficient safe manner, including motor vehicles, buses, trucks and vulnerable road users.

The following are the reasons why a roundabout junction constitutes the most suitable layout:

- A roundabout is a large physical feature which informs drivers of change. The inscribed circle diameter of this roundabout is 45m
- A roundabout minimises delay for road users whilst maintaining safe passage of all road users through the junction
- The roundabout is in a rural setting, remote from high volumes of vulnerable road users

4.2.2 Bearna East Roundabout

The Bearna – Moycullen Road L1321 is a local road connecting Bearna Village to the N59 Moycullen Road. The proposed road development mainline intersects the Bearna – Moycullen Road L1321 north of Bearna Village creating a junction in the area. The existing Bearna – Moycullen Road geometry in the vicinity of this proposed junction is of a reasonable standard and the cross-section is constrained due to property boundaries.

In the vicinity of the proposed junction the Bearna – Moycullen Road L1321 caters for average annual daily traffic volumes of approximately 2,300 AADT per day in the 2039 design year. The proposed road development in the same vicinity caters for average annual daily traffic volumes of approximately 11,000 AADT on the western approach and 18,000 AADT on the eastern approach in the 2039 design year with 3% thereof constituting Heavy Goods Vehicles (HGV's).

The main objective of the junction is to increase convenience, comfort and safety while at the same time enhancing the efficient movement of all road users.

At this location one of the overriding objectives is providing connectivity and access to the village of Bearna and its surrounds. It is desirable to provide a roundabout junction in order to enhance operational safety and performance. It is beneficial to provide a major junction in this location taking cognisance of the existing developments in the area and future development proposals. The provision of a roundabout junction would increase convenience, comfort and safety and facilitate the efficient movement of all road users.

The following are the reasons why a roundabout junction constitutes the most suitable layout:

- A roundabout is a large physical feature which informs drivers of change. The inscribed circle diameter of this roundabout is 60m
- A roundabout minimises delay for road users whilst maintaining safe passage of all road users through the junction
- The roundabout is designed to accommodate traffic volumes, the roundabout is un-signalised and each arm has a RFC less than 85%. The roundabout has sufficient capacity to cater for future development and growth
- Entry flaring and entry width in accordance with TII –DN-GEO-03060 has been provided in order to enhance the capacity and operational performance of the roundabout
- Conflicting right turn movements are well managed
- Flows are more balanced on the main and minor roads at this location
- Appropriate design standards are adopted which minimise safety risks for all road users (motor vehicles, buses, trucks and vulnerable road users)
- The roundabout is in a rural setting, remote from high volumes of vulnerable road users

4.2.3 Cappagh Road Junction

Cappagh Road is a local road at the western terminus of the Western Distributor Road which is an urban street in the residential area of Knocknacarra, on the western edges of the city. Cappagh Road runs north south connecting the hinterland to Western Distributor Road and onwards south to the existing R336. The proposed road development mainline intersects Cappagh Road north of the Western Distributor Road creating a junction in the area. The existing Cappagh Road geometry in the vicinity of this proposed junction is sub-standard and the cross-section is constrained due to existing property boundaries. It is proposed to upgrade the Cappagh Road south to its connection with the Western Distributor Road.

In the vicinity of the proposed junction, the Cappagh Road to the south of the proposed road development mainline caters for average annual daily traffic volumes of approximately 6,500 AADT per day in the 2039 Design Year. The daily volumes to the north of proposed road development in 2039 Design Year are low at less than 300.

The proposed road development in the same vicinity caters for average annual daily traffic volumes of approximately 18,000 AADT in the 2039 Design Year with 3% thereof constituting Heavy Goods Vehicles (HGV's).

The main objectives of this junction is to inform the driver of the change from the rural environment to the urban environment, to facilitate the cross movement of vulnerable road users and to provide connectivity to match demand. It is desirable to provide a signalised junction in order to enhance operational safety and performance. The signalised junction has been designed in accordance with DN-GEO-03044.

The following are the reasons why a signalised junction is the most suitable layout:

- Detailed traffic modelling was undertaken using LinSig[1] to optimise this junction. This has the effect of reducing the ratio of flow to capacity and providing residual capacity for the future. This traffic modelling indicated that the junction would operate within capacity during all modelled time periods with each arm having an RFC less than 90%
- Dedicated right turn lanes have been included at all arms of this junction to manage conflicting right turn movements and to enhance the capacity and operational performance of the signalised junction
- A signalised junction provides an appropriate junction between the proposed road development mainline and an urban street designed in accordance with the design principles set out in the Design Manual for Urban Roads and Streets
- The Galway City Development Plan contains an objective for a transport link between Cappagh Road and Ballymoneen Road along the lines of the proposed road development, with the Western Distributor Road becoming a dedicated public transport, cycling and pedestrian movement corridor
- Initial tests of this junction as a roundabout indicated that the predicted turning movements were imbalanced, resulting in limited gaps in traffic forming on the main east-west corridor, thereby restricting movements from the minor approaches, particularly during peak hour periods. A signalised junction prevents total control by the dominant traffic movement during peak hour traffic flow

4.2.4 Ballymoneen Junction

Ballymoneen Road is an urban street which runs in a north south direction, connecting Rahoon Road to the Western Distributor Road and onwards south to the existing R336. The proposed road development mainline intersects Ballymoneen Road north of the Western Distributor Road creating a junction in the area. The existing Ballymoneen Road geometry in the vicinity of this proposed junction is

[1] LinSig is an industry standard software tool which allows traffic engineers to model signalised junctions and their effect on capacities and queuing. LinSig also allows for the optimisation of traffic signals to increase capacity and reduce delays at junctions

sub-standard. There also is a new secondary school with over 900 pupils situated on this street.

In the vicinity of the proposed junction, the Ballymoneen Road to the south of the proposed road development mainline caters for average annual daily traffic volumes of approximately 6,000 AADT per day in the 2039 Design Year. The daily volumes to the north of the proposed road development in 2039 Design Year are lower at 4,000 AADT.

The daily traffic volumes on the proposed road development is approximately 18,000 AADT in the 2039 Design Year with 2% thereof constituting Heavy Goods Vehicles (HGV's).

One of the main objectives of this junction is to inform the driver of the change from single carriageway with at-grade connections to a dual carriageway type cross section with grade separated junctions, whilst also facilitating the cross movement of vulnerable road users and to provide connectivity to match demand. It is considered desirable to provide a signalised junction in order to enhance operational safety performance and to facilitate the efficient movement of all road users. The signalised junction has been designed in accordance with DN-GEO-03044.

The following are the reasons why a signalised junction is the most suitable layout:

- Detailed traffic modelling was undertaken using LinSig to optimise this junction. This has the effect of reducing the ratio of flow to capacity and providing residual capacity for the future. This traffic modelling indicated that the junction would operate within capacity during all modelled time periods with each arm having an RFC less than 90%
- Dedicated right turn lanes have been included at all arms of this junction to manage conflicting right turn movements, a dedicated left turn lane is included on the proposed road development travelling eastbound and lane continuity per Figure 2/11 of TII-DN-GEO-03044 is included on the proposed road development travelling westbound at this junction. Each of these measures enhances the capacity and operational performance of the signalised junction
- A signalised junction provides an appropriate junction between the proposed road development and an urban street designed in accordance with the design principles set out in the Design Manual for Urban Roads and Streets
- The Galway City Development Plan contains an objective for a transport link between Cappagh Road and Ballymoneen Road along the lines of the proposed road development, with the Western Distributor Road becoming a dedicated public transport, cycling and pedestrian movement corridor
- Initial tests of this junction as a roundabout indicated that the predicted turning movements were imbalanced, resulting in limited gaps in traffic forming on the main east-west corridor, thereby restricting movements from the minor approaches, particularly during peak hour periods. A signalised junction prevents total control by the dominant traffic movement during peak hour traffic flow

4.2.5 Proposed Road Development Slip Road Types

Detail on side roads and interchanges, and their geometric parameters, provided as part of the proposed road development are outlined within **Chapter 3, Alignment Geometry**.

Table 4.1 details the merge and diverge types utilised at each grade separated junction on the proposed road development. These layouts are detailed within DN-GEO-03060. Those standard layouts are illustrated in **Figures 4.2** to **4.6**. Geometric parameters per tables 7.1 (merges) and 7.2 (diverges) of DN-GEO-03060 were utilised, taking into consideration the 100km/h design speed of the dual carriageway section of the proposed road development.

Table 4.1: Summary of the proposed Standard layouts for the proposed road development GSJs slip roads

	N59 Letteragh Junction	**N84 Headford Road Junction**	**N83 Tuam Road Junction**	**N6 Coolagh Junction**
EB Diverge	Layout A	Layout A	Layout B	Layout B
WB Merge	Layout A	Layout A	Layout C, Option 1	Layout A
WB Diverge	Layout B	Layout B	Layout B (loop)	Layout B
EB Merge	Layout A	Layout C, Option 1	Layout A (loop)	Layout A

Figure 4.2: TII publication DN-GEO-03060 parallel Merge lane layout A

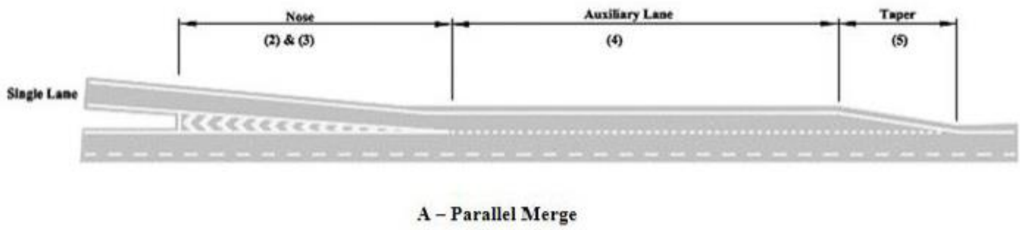


Figure 4.3: TII publication DN-GEO-03060 single lane parallel diverge layout A

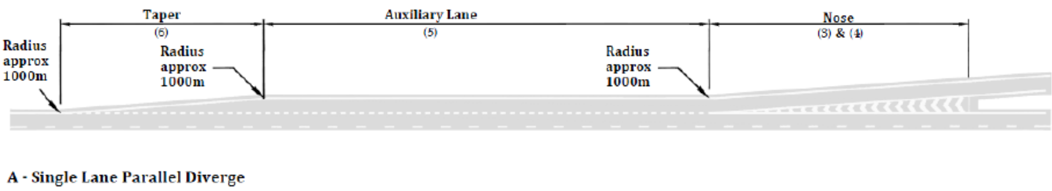


Figure 4.4: TII publication DN-GEO-03060 single lane parallel diverge with diverging two lane connector road (diverge layout B)

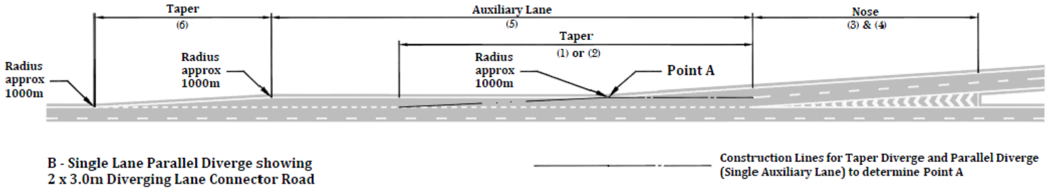


Figure 4.5: TII publication DN-GEO -03060 lane gain with Ghost Island Merge layout C Option 1

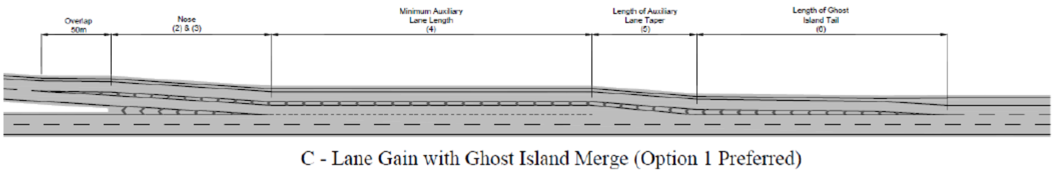
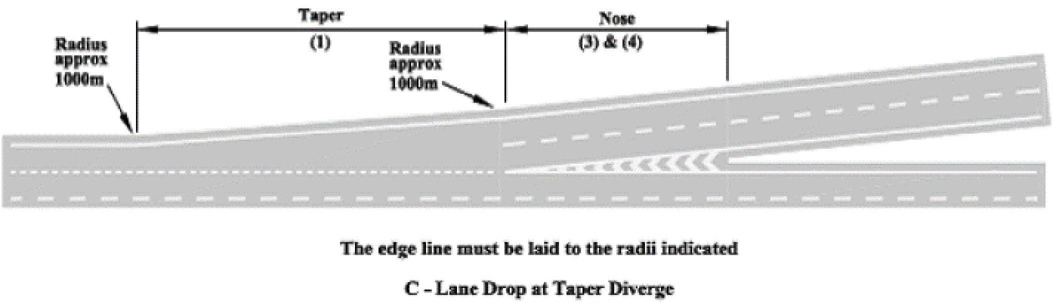


Figure 4.6: TII publication DN-GEO-03060 lane drop at taper diverge layout C



4.2.6 N59 Letteragh Junction

East of the proposed N59 Letteragh Junction the proposed road development mainline is an urban motorway. As per Table 6.1 of TII-DN-GEO-03031, full grade separation is required for junctions providing access to a motorway. The N59 Letteragh Junction is a signalised diamond grade separated junction and it is offset from the existing N59. The purpose of this offset is two-fold, firstly to minimise the direct impact on residential property at the N59 crossing and secondly to provide better connectivity and traffic distribution from the proposed road development to Knocknacarra to the south and the N59 area to the north. The N59 Link Road South connects to the Letteragh Road and Rahoon Road which effectively distributes traffic accessing NUIG South (south of the Quincentenary Bridge), Knocknacarra and UHG, whilst the N59 Link Road North facilitates traffic accessing NUIG North (NUIG Sporting Campus), N59 and Connemara. The following are the reasons why a signalised diamond grade separated junction is the most suitable layout:

- A diamond grade separated junction limits the impact to the surrounding area. Detailed traffic modelling determined that signalised junctions at the termini of the slip roads best manage conflicting traffic flows

- Grade separation is required for junctions providing access to a motorway
- A signalised junction provides an appropriate junction between the proposed road development mainline and an urban street designed to the Design Manual for Urban Roads and Streets, and the N59 Link Road is a street with footpaths and lighting
- Signalised junctions prevent total control by the dominant traffic movements during peak hour traffic flows. Consequently, all junctions on the N59 Link Road, up and downstream of the N59 grade separated junction, are signalised
- Detailed traffic modelling was undertaken using LinSig to optimise this junction. This has the effect of reducing the ratio of flow to capacity and providing residual capacity for the future. This traffic modelling indicated that the junction would operate within capacity during all modelled time periods with each arm having an RFC less than 90%
- The eastbound diverge develops and incorporates a dedicated left turn lane and right / straight ahead lane on the approach to the N59 Link Road in order to accommodate traffic volumes. The westbound diverge incorporates a dedicated left and right/straight ahead lane on the approach to the N59 Link Road in order to accommodate traffic volumes travelling from the proposed road development. Both measures enhance the capacity and operational performance of the grade separated junction
- The N59 Link Road South and the N59 Link Road North incorporate dedicated left turn lanes as they approach the westbound merge and eastbound merge respectively. The link between the grade separated arms incorporates lane continuity to enhance the capacity and operational performance of the grade separated junction
- The N59 Letteragh Junction incorporates vulnerable road user facilities such as dedicated crossing points for pedestrians and cyclists. Cyclists can merge and diverge with the mainline of the proposed road development at this junction from the west only

4.2.7 N84 Headford Road Junction

The proposed road development mainline is an urban motorway in the area of the proposed N84 Headford Road Junction. As per Table 6.1 of TII-DN-GEO-03031, full grade separation is required for junctions providing access to a motorway. The N84 Headford Road Junction is a signalised diamond grade separated junction and it is located on the N84 Headford Road. The junction is located directly on the N84 to match demand at this entry point to the city from County Mayo and the northern part of County Galway.

The following are the reasons why a signalised diamond grade separated junction is the most suitable layout:

- A diamond grade separated junction limits the impact to the surrounding area. Detailed traffic modelling determined that signalised junctions at the termini of the slip roads best manage conflicting traffic flows
- Grade separation is required for junctions providing access to a motorway
- Signalised junctions prevent total control by the dominant traffic movements during peak hour traffic flows

- Detailed traffic modelling was undertaken using LinSig to optimise this junction. This has the effect of reducing the ratio of flow to capacity and providing residual capacity for the future. This traffic modelling indicated that the junction would operate within capacity during all modelled time periods with each arm having an RFC less than 90%
- The eastbound diverge develops and incorporates a dedicated left turn lane as it approaches the N84 Headford Road in order to accommodate traffic volumes. The westbound diverge incorporates a dedicated left and right/straight ahead lane on the approach to the N84 Headford Road in order to accommodate traffic volumes travelling from the proposed road development
  Both measures enhance the capacity and operational performance of the grade separated junction
- The N84 Headford Road South and the N84 Headford Road North incorporate dedicated left turn lanes as they approach the westbound merge and eastbound merge respectively. The link between the grade separated arms incorporates lane continuity to enhance the capacity and operational performance of the grade separated junction
- The eastbound merge incorporates two lanes on the approach to the proposed road development in order to accommodate traffic volumes
- The N84 Headford Road Junction incorporates vulnerable road user facilities

4.2.8 N83 Tuam Road Junction

The provision of a full movement, high quality junction at the intersection of the proposed road development and the existing N83 is attractive and necessary due to its location adjacent to the primary business and industrial centres in Galway and the fact that the N83 is a primary access to the city for the north of the county and the greater western region. Some of the business and commercial areas served by the N83 include Ballybane Industrial Estate, Parkmore Industrial Estates, City North Business Park, City East Business Park, Galway Technology Park, Mervue Business Park and Liosban Industrial Estate. These business and industrial areas are major attractions due to the level of employment facilitated and are thus major trip generators.

The N83 Tuam Road Junction is comprised of the following slip roads and link roads:

- Eastbound diverge
- Westbound merge
- Existing N83 Tuam Road
- City North Business Park Link
- Parkmore Link Road
- Eastbound Merge
- Westbound diverge

The combination of slip roads and link roads is integral to the safe and effective operation of the junction. Detailed traffic modelling determined that signalised junctions best manage conflicting traffic flows associated with this junction as a whole. Therefore, the junction of the slip roads with the connecting roads (N83 or Parkmore Link Road) shall be signalised. The following junctions associated with the N83 Tuam Road Junction are signalised. The junctions, which are separate from the signalised slip termini, are as follows:

- City North Business Park Junction
- Business Park Junction 2

The following junctions associated with the N83 Tuam Road Junction are un-signalised due to lower traffic volumes forecast.

- Parkmore Industrial Estate Junction

The following are the reasons why the N83 Tuam Road Junction, and its sub junctions and associated link roads, is the most suitable layout:

- The layout of the N83 Tuam Road facilitates access to the existing N83, the Parkmore Link Road and onwards to the major industrial zones in Galway from the proposed road development
- Grade separation is required for junctions providing access to a motorway
- Signalised junctions prevent total control by the dominant traffic movements during peak hour traffic flows
- Detailed traffic modelling was undertaken using LinSig to optimise this junction. This has the effect of reducing the ratio of flow to capacity and providing residual capacity for the future. This traffic modelling indicated that the junction would operate within capacity during all modelled time periods with each junction movement having an RFC less than 90%
- The eastbound diverge incorporates one dedicated left lane and right lane on the approach to the N83 Tuam Road in order to accommodate traffic volumes travelling from the proposed road development. The eastbound diverge also develops an additional right turn lane to accommodate traffic volumes travelling from the proposed road development mainline
- The westbound merge incorporates two lanes on the approach to the proposed road development mainline in order to accommodate traffic volumes
- Following detailed traffic modelling, additional vehicular lanes were added to the existing N83 between the eastbound diverge and City North Business Park Junction in order to enhance the capacity and operational performance of the junction and to accommodate traffic volumes
- Lane continuity per Figure 2/11 of TII-DN-GEO-03044 is included on the existing N83 travelling southbound at City North Business Park Junction allowing a safe transition from a dual type cross section to a single type cross section. Similarly, north of the eastbound diverge junction lane continuity per Figure 2/11 of TII-DN-GEO-03044 is included on the existing N83 in order to safely transition from a dual type cross section to a single type cross section
- Dedicated right turn lanes have been included at relevant arms of City North Business Park Junction and Business Park Junction 2 to manage conflicting right turn movements and to enhance the capacity and operational performance of the signalised junctions

- Dedicated right turn lanes have been included at relevant locations along Parkmore Link Road and the upgraded N83 to manage conflicting right turn movements and to enhance the capacity and operational performance of the signalised junctions
- The Galway Transport Strategy outlines the requirement for public transport and vulnerable road user facilities on the existing N83 in the vicinity of the proposed junction. Galway City Council are currently progressing a planning application for the upgrade to the existing N83. The design incorporates a dedicated city bound bus corridor and dedicated vulnerable road user facilities. The proposed N83 Tuam Road Junction incorporates the bus lane and vulnerable road user facilities as part of its design
- The westbound diverge incorporates two lanes on the approach to the Parkmore Link Road in order to accommodate traffic volumes
- 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

4.2.9 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 will become the primary access to Galway also from the south once the M17/M18 is operational. This area to the east of Galway is also the focus of future development for Galway with the development of Ardaun.

The N6 Coolagh Junction is comprised of the following slip roads and link roads:

- Eastbound diverge to Coolagh Junction
- Westbound merge from Coolagh Junction
- Coolagh at-grade junction
- Eastbound merge from Coolagh Junction
- Westbound diverge to Coolagh Junction
- Southbound diverge to R446
- Northbound merge from R446

The combination of slip roads and link roads is integral to the safe and effective operation of the junction. Detailed traffic modelling determined that signalised junctions best manage conflicting traffic flows associated with the Coolagh at-grade junction and the slips that connect thereto.

The following are the reasons why the N6 Coolagh Junction, its sub junctions, and associated link roads, is the most suitable layout:

- The layout of the N6 Coolagh Junction facilitates access to the existing N6, the R446 and the Briarhill link and onwards to the major industrial zones in Galway from the proposed road development
- Grade separation is required for junctions providing access to a motorway
- Signalised junctions prevent total control by the dominant traffic movements during peak hour traffic flows. Consequently, the Coolagh at-grade junction associated with the N6 Coolagh Junction is signalised
- Detailed traffic modelling was undertaken using LinSig to optimise this junction. This has the effect of reducing the ratio of flow to capacity and providing residual capacity for the future. This traffic modelling indicated that the junction would operate within capacity during all modelled time periods with each junction movement having an RFC less than 90%
- The eastbound diverge to Coolagh Junction incorporates a dedicated left and a right / straight ahead lane on the approach to the Coolagh at-grade junction in order to accommodate traffic volumes travelling from the proposed road development mainline. This diverge also develops an additional right turn lane to accommodate traffic volumes travelling from the proposed road development mainline. These measures enhance the capacity and operational performance of the signalised junction
- The westbound merge from Coolagh at-grade junction incorporates two lanes on the approach to the proposed road development in order to accommodate traffic volumes. The two lanes taper to one in advance of joining the proposed road development. The lane has been removed in accordance with TII-DN-GEO-03060
- The westbound diverge to Coolagh Junction incorporates a dedicated left and a right/straight ahead lane on the approach to the Coolagh at-grade junction in order to accommodate traffic volumes travelling from the proposed road development. From this diverge the Southbound diverge to the R446 develops. This diverge removes traffic from the Coolagh at-grade junction thereby enhancing the capacity and operational performance of the signalised junction
- The northbound merge to the proposed road development mainline from the R446 removes traffic from the Coolagh at-grade junction thereby enhancing the capacity and operational performance of the signalised junction
- Dedicated left and right turn lanes have been included on the Briarhill link travelling toward the Coolagh at-grade junction. These lanes enhance the capacity and operational performance of the signalised junction
- Dedicated right turn lanes have been included on the R446 link travelling toward the Coolagh at-grade junction. These lanes enhance the capacity and operational performance of the signalised junction
- 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

4.3 Non-Direct Access Junctions

The following section details junctions which are upgraded, maintained, or modified as part of the scheme, but they do NOT provide a direct access to the proposed road development.

4.3.1 Na Foraí Maola Junction

This junction is located in the area of the Troscaigh/Na Foraí Maola Overbridge. The junction connects the Troscaigh/Na Foraí Maola Overbridge Link to the southern Na Foraí Maola Road to Troscaigh link road. The junction is located at Ch. 1+380 approximately along the proposed road development mainline.

The junction is Simple T-Junction per Figure 2.1 of TII-DN-GEO-03060.

The forecast traffic volumes on the proposed roads are less than 600 annual average daily traffic (AADT) and thus a simple T-Junction is deemed safe, suitable and appropriate.

4.3.2 Troscaigh Junction

This junction is located in the area of the Troscaigh / Na Foraí Maola Overbridge. The junction connects the Troscaigh / Na Foraí Maola Overbridge Link to the northern Na Foraí Maola Road to Troscaigh Link Road. The junction is located at Ch. 1+380 approximately along the proposed road development mainline.

The junction is Simple T-Junction per Figure 2.1 of TII-DN-GEO-03060. The forecast traffic volumes on the proposed roads are less than 600 AADT and thus a simple T-Junction is deemed safe, suitable and appropriate.

4.3.3 Na Foraí Maola Local Junction

This junction is located in the area of the Troscaigh / Na Foraí Maola Overbridge. The junction connects the northern Na Foraí Maola Road to Troscaigh Link Road to the existing Na Foraí Maola Road. It is north of the mainline located at approximately Ch. 1+150 along the proposed road development mainline.

The junction is Simple T-Junction per Figure 2.1 of TII-DN-GEO-03060. The forecast traffic volumes on the proposed and existing road are forecast at less than 600 AADT and thus a simple T-Junction is deemed safe, suitable and appropriate.

4.3.4 An Chloch Scoilte Junction

A junction with a local road and the Aille Road (L5384) is severed by the proposed road development in the Aille area. The junction is located at Ch. 3+325 along the proposed road development mainline.

It is proposed to realign the road connecting to the tertiary road and to provide a Simple T-Junction per Figure 2.1 of TII-DN-GEO-03060. The forecast traffic volumes on the realigned road are less than 100 AADT, the forecast traffic volumes on the Aille Road are less than 600 AADT. Thus, a simple T-Junction is deemed safe, suitable and appropriate.

4.3.5 Clybaun Road Junction

A junction of the Clybaun Road and the Rahoon Road is severed by the proposed road development in the Rahoon / Clybaun area. The junction is north of the proposed road development mainline located at approximately Ch. 6+340.

It is proposed to realign the road connecting to the tertiary road and to provide Simple T-Junctions per Figure 2.1 of TII-DN-GEO-03060. The forecast traffic volumes on the realigned road are less than 600 AADT, the forecast traffic volumes on the Rahoon Road is 4,400 AADT. Thus, a simple T-Junction is deemed safe, suitable and appropriate.

4.3.6 Gort Na Bró Junction

The N59 Link Road South connects the proposed road development to Rahoon Road via the Rahoon Road Junction. From the Rahoon Road Junction connection to the Western Distributor Road is provided via the Gort Na Bró Link Road and the Gort Na Bró Road. Providing this connectivity results in an increase in the level of traffic on the existing road network including junctions in the Knocknacarra area. As a consequence of this it is proposed to upgrade junctions in this area, the Gort Na Bró Junction is one of these junctions.

It is proposed to remove the existing roundabout and replace it with a signalised junction. To comply with the requirements set out in the GTS at this location, it is proposed to provide a bus lane through the junction as well as providing facilities for vulnerable road users. The forecast traffic volumes on the Gort Na Bró Road are 2,150 AADT, the forecast traffic volumes on the Western Distributor Road are 8,200 AADT, the forecast traffic volumes from the An Logán estate are less than 600 AADT. A signalised junction is deemed safe, suitable and appropriate as it can best manage conflicting traffic flows and road user types. Further, a signalised junction provides an appropriate junction with an urban street designed to the Design Manual for Urban Roads and Streets.

4.3.7 Gateway Retail Park Junction.

The N59 Link Road South connects the proposed road development to Rahoon Road via the Rahoon Road Junction. From the Rahoon Road Junction connection to the Western Distributor Road is provided via the Gort Na Bró Link Road and the Gort Na Bró Road. Providing this connectivity results in an increase in the level of traffic on the existing road network including junctions in the Knocknacarra area. As a consequence of this it is proposed to upgrade junctions in this area, the Gateway Retail Park Junction is one of these junctions.

It is proposed to remove the existing link between Gateway Retail Park and Gort Na Bró Roundabout and replace it with an alternative link, namely the Gateway Retail Park Link Road, connecting to the Gort Na Bró Road. The forecast annual average daily traffic volumes on the Gort Na Bró Road are 2,150 AADT, the forecast volumes on the Gateway Retail Park Link Road is 1,000 AADT. An un-signalised junction is proposed and deemed safe, suitable and appropriate. Vulnerable road user facilities are provided at this junction location.

4.3.8 Rahoon Road Junction

The N59 Link Road South connects the proposed road development to Rahoon Road via the Rahoon Road Junction. From the Rahoon Road Junction connection to the Western Distributor Road is provided via the Gort Na Bró Link Road and the Gort Na Bró Road. Providing this connectivity results in an increase in the level of traffic on the existing road network including junctions in the Knocknacarra area. As a consequence of this it is proposed to upgrade junctions in this area, the Rahoon Road Junction is one of these junctions.

It is proposed to realign Bóthar Diarmuida, via the N59 Link Road South, and connect to the Rahoon Road and onwards to the Gort Na Bró Road.

The existing junction is un-signalised. It is proposed to signalise this junction as part of the proposed road development. It is proposed to provide facilities for vulnerable road users as part of the GTS measures and dedicated right turning lanes on each arm of the junction are provided in order to enhance its capacity and operational performance. The forecast traffic volumes on the Gort Na Bró Road are 2,150 AADT, the forecast traffic volumes on the N59 Link Road South are 6,300 AADT, the forecast traffic volumes on the Rahoon Road are 8,400 AADT. A signalised junction is deemed safe, suitable and appropriate as it can best manage conflicting traffic flows. Further, a signalised junction provides an appropriate junction with an urban street designed to the Design Manual for Urban Roads and Streets.

4.3.9 Bóthar Diarmuida Junction

The N59 Link Road South connects the proposed road development to Rahoon Road via the Rahoon Road Junction. From the Rahoon Road Junction connection to the Western Distributor Road is provided via the Gort Na Bró Link Road and the Gort Na Bró Road. Providing this connectivity results in an increase in the level of traffic on the existing road network including junctions in the Knocknacarra area. As a consequence of this it is proposed to upgrade junctions in the area, the Bóthar Diarmuida Junction is one of these junctions.

It is proposed to realign Bóthar Diarmuida, via the N59 Link Road South, and connect to the Rahoon Road. This necessitates the provision of a junction from the existing Bóthar Diarmuida, which serves Rosán Glas and Bun An Chnoic, to the N59 Link Road South. The forecast annual average daily traffic volumes on the N59 Link Road South are 6,300 AADT, the forecast traffic volumes from Bóthar Diarmuida (Rosán Glas and Bun An Chnoic) are 300 AADT. An un-signalised junction is proposed and deemed safe, suitable and appropriate. Vulnerable road user facilities are provided at this junction location.

4.3.10 Letteragh Road Junction

The Letteragh Road Junction is located on the N59 Link Road South. It is proposed as a signalised junction and connects the proposed road development to the existing Letteragh Road.

It is proposed to provide facilities for vulnerable road users and dedicated right turning lanes on each arm of the junction in order to enhance its capacity and operational performance. The forecast traffic volumes on the N59 Link Road South north of the junction are 14,000 AADT, the forecast volumes on the N59 Link Road South, south of the junction are 6,300 AADT the forecast traffic volumes on the Letteragh Road are 9,800 AADT. A signalised junction is deemed safe, suitable and appropriate as it can best manage conflicting traffic flows. Further, a signalised junction provides an appropriate junction with an urban street designed to the Design Manual for Urban Roads and Streets.

4.3.11 Bushypark Junction

The Bushypark Junction is located at the northern end of the N59 Link Road North. It is proposed as a signalised junction and connects the proposed road development to the existing N59 Road.

It is proposed to provide facilities for vulnerable road users and dedicated right turning lanes on each arm of the junction in order to enhance its capacity and operational performance. The forecast traffic volumes on the N59 Link Road North are 11,800 AADT, the forecast traffic volumes on the N59 Moycullen Road North of the proposed junction are 18,900 AADT. A signalised junction is deemed safe, suitable and appropriate as it can best manage conflicting traffic flows. Further, a signalised junction provides an appropriate junction with an urban street designed to the Design Manual for Urban Roads and Streets.

4.3.12 Ballybrit Crescent Junction

This junction is located in Briarhill area between the R339 Monivea Road and Ballybrit Crescent. This junction is impacted by the proposed road development and will need to be reconfigured. The junction is located just north of the mainline at approximately Ch. 15+890 along the proposed road development.

The existing junction is signalised. This junction is targeted as part of the GTS for upgrade. Upgrade and works, including the provision of dedicated bus facilities and facilities for vulnerable road users, and realignment works are proposed as part of the proposed road development. Footpaths are maintained in the area at the current level of provision.

4.3.13 Lynch Junction

Lynch Junction is an existing signalised junction. This junction was recently 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.

4.3.14 City East Business Park Junction

The City East Business Park Junction is located along the existing N6 dual carriageway south of City East Business Park. It is proposed as a signalised junction and connects City East Business Park to the existing N6.

It is proposed to provide dedicated right turning lanes on each arm of the junction in order to enhance its capacity and operational performance. The forecast traffic volumes on the N6 are 16,000 AADT, the forecast traffic volumes from City East Business Park are 1,800 AADT. A signalised junction is deemed safe, suitable and appropriate as it can best manage conflicting traffic flows.

4.4 Traffic Monitoring and Control

4.4.1 Galway Transportation Unit

Galway City Council established the Galway Transportation Unit (GTU) to develop and implement an Integrated Transport Solution for Galway City in accordance with best practice and the objectives outlined in Transport 21. Working in partnership with transport stakeholders in the City, the Integrated Transport Solution will be developed and implemented to promote increased use of public and non-car based transport services, overcome existing congestion and delays in the network and promote a sustainable transport system for Galway City.

4.4.2 Proposed Road Development Traffic Control

An integrated traffic monitoring and control system shall be provided as part of the proposed road development. This system shall be compatible with the existing infrastructure and systems utilised by Galway City Council on the existing N6 multi modal corridor. An integrated traffic monitoring and control system could enhance the capacity and operational performance of the entire Galway City transportation network. The Lackagh Tunnel and Galway Racecourse Tunnel are proposed to be monitored remotely from the Dublin Port Tunnel Control Building with responsibility for traffic management, tunnel safety management, emergency and contingency planning, equipment and infrastructure inspection and maintenance of the tunnels.

5 Ground Conditions, Topography & Earthworks

5.1 General

This chapter provides an assessment of the geology, ground conditions and geotechnical aspects of design and construction for the proposed road development.

The overall proposed road development has been divided into four sections for the purpose of this chapter:

- Section 1: Chainage 0+000 to 8+850 (An Baile Nua to east of the N59 Moycullen Road)
- Section 2: Chainage 8+850 to 9+500 (East of the N59 Moycullen Road to the River Corrib)
- Section 3: Chainage 9+500 to 14+150 (River Corrib to east of N83 Tuam Road)
- Section 4: Chainage 14+150 to 17+500 (East of N83 Tuam Road to the existing N6 at Ardaun, Coolagh)

The proposed road is also broken into a series of earthworks areas, with the dividing lines between areas being either a physical boundary, such as a river, a proposed engineering boundary, such as a viaduct or tunnel, or an earthworks boundary such as the transition between an embankment and a cutting. In total there are 35 earthworks areas (35 along the mainline and the N59 Link Road). Areas 1 to 14 along with the N59 Link Road are located west of the River Corrib and areas 16 to 35 are located to the east of the River Corrib. The extents over the River Corrib is designated as earthworks area 15. The areas are summarised in **Appendix A.5.2** and are used throughout this chapter.

Section 5.2 of this chapter describes the design basis and technical limitations of the assessment of the underlying geology and ground conditions and the geotechnical aspects of the design and construction. **Section 5.3** presents the desk study data collection sources. **Section 5.4** presents the preliminary site investigations that were undertaken and an overview of the receiving environment including geomorphology and topography, hydrogeology, superficial deposits / subsoils, bedrock geology contaminated ground and mineral / historical resources. **Section 5.5** describes the ground conditions. **Section 5.6** describes the geotechnical aspects of road design including cut slopes, embankments, subgrade, structure foundations, earthwork material acceptability, contaminated land, soil chemistry, karst; and tunnelling and **Section 5.7** presents the geotechnical design risk register.

5.2 Design Basis

The assessment of the geology, ground conditions and geotechnical aspects of the design and construction of the proposed road development is based on the following information:

- The proposed development boundary

- The vertical and horizontal alignment
- The available ground investigation information

The ground conditions along the proposed road development were determined using various sources of information including historic data, photographic evidence, observations from site walkovers, intrusive and non-intrusive site investigations, laboratory testing and on site investigation monitoring.

The overburden and bedrock formations along the proposed road development are discussed in terms of:

- Location
- Classification
- Earthworks acceptability
- Permeability

The geotechnical aspects of the design and construction of the proposed road development are discussed in **Section 5.6** and include the following:

- Cut slopes
- Embankments
- Subgrade
- Structure Foundations
- Earthwork Material Acceptability
- Contaminated Land
- Soil Chemistry
- Karst
- Tunnelling

A conservative design approach has been adopted for this assessment. In the event that supplementary information is made available the information will be assessed and the results of the assessment may lead to a more efficient design solution.

5.2.1 Technical Limitations

The available information includes existing data from earlier investigations into the region as well as project specific field surveys commissioned for the proposed road development.

These data points provide valuable information on the soils and geology environment at point locations and between each point the data is assessed by conservative interpretation.

While soils and geology can vary, the exploratory locations were selected following the completion of the comprehensive baseline 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 is 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 collection and in instances where it did not, supplementary ground investigation was undertaken. Based on the comparability of the ground investigations and the baseline collection the information is deemed sufficient to complete this evaluation.

5.3 Desk Study

A number of sources of information were reviewed in order to evaluate the geology and ground conditions along the proposed road development. These have been divided into three sections:

- Third Party Documentation and Data Sources
- Previous / Historical Ground Investigation
- Consultation

5.3.1 Third Party Documentation and Data Sources

The following are design reports, documentation containing geological and geotechnical information, geological data sources and other relevant data points.

- Current and historical Ordnance Survey maps available for the study area (1:2,500 and 1:10,560 scales), 2014
- 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 2016
- Geological maps of the site area produced by the Geological Survey of Ireland (GSI) (www.dccae.gov.ie)
- Teagasc and the Environmental Protection Agency Irish Soil Information System (http://gis.teagasc.ie/soils/index.php)
- Results from karst field surveys reported in the June 2016 Karst Report
- 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)
- N6 Galway City Outer Bypass Preliminary Design Report Volume 1 (2006)

5.3.2 Previous / Historical Ground Investigation

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, 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

In addition, recent ground investigation reports along the proposed road development 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

5.3.3 Consultation

Consultation was carried out with the relevant bodies as detailed below:

- Geological Survey of Ireland (GSI)
- Department of Housing, Planning, Community and Local Government
- Mineral Exploration & Mining Division of the Department of Communications, Climate Action and Environment
- Teagasc
- Office of Public Works (OPW)
- Galway County Council
- Galway City Council
- Environmental Protection Agency (EPA)
- Landowners

5.4 Preliminary Site Investigation

This section details the field studies commissioned project specific for the proposed road development and also provides a general overview of the development in terms of geomorphology, geology, hydrogeology and historical development.

5.4.1 Field Studies

In order to establish the ground conditions and geotechnical characteristics along the proposed development, a number of field studies were commissioned. The scope of these studies include the following:

- Shell and auger boreholes
- Rotary core boreholes
- Trial pits
- Window samples
- Geophysical surveys
- Groundwater level monitoring
- Geotechnical and environmental testing on soil and groundwater samples
- Site walkovers

Preliminary ground investigations including the above scope are detailed as follows:

- N6 GCTP Phase 1 Ground Investigation Contract I. July 2014
- 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, January 2017

The ground activity for the investigations listed above are summarised in **Table 5.1:**

The ground investigation factual reports for each of these ground investigation is included in **A.5.1**. A summary of the project specific ground investigation has also been provided in **Table 5.1**.

Table 5.1: Summary of Project Specific Ground Investigations

Project Specific Ground Investigation						
Ground investigation activity	**Unit**	**Phase I CI**	**Phase II CI**	**Phase III CI**	**Phase III CII**	**Phase III CIII**
Cable Percussive Boreholes	nr			29		1
Rotary Coreholes	nr	2	4	40	5	3
Rotary Percussive Holes for water monitoring wells or pump tests	nr		5			1
Trial Pits	nr			38		4
Soakaway Testing	nr			2		11
Window Samples	nr			4		
Multi Analysis Surface Wave	m	1726				
Seismic Refraction	m	1726	1285	8496		2175
2D Resistivity Survey	m		973	6027		2175
Electrical Resistivity Tomography	m				1897	
Microgravity	stations				118	

5.4.2 Site Description

An overview of the proposed road development is provided in the following subsections. The aspects considered are as follows:

- Geomorphology and Topography
- Hydrogeology
- Superficial Deposits / Subsoils
- Bedrock Geology
- Contaminated Ground
- Mineral / Historical Resources

5.4.2.1 Geomorphology and Topography

The general geomorphology of Section 1 (Ch. 0+000 to 8+850) consists of gently undulating to hummocky topography overlying Granite. Within this section of the proposed road development the existing ground level is lowest at the proposed Bearna West Roundabout (~10m OD) at Ch. 0+000. The ground level undulates with existing lows at Ballard, Ch. 3+950 (~20mOD) and in Dangan at the N59 Moycullen Road Ch. 8+850 (~30mOD). The existing high points in Section 1 are located at Troscaigh Thiar, Ch. 1+800 (~60mOD), Ballyburke, Ch. 5+350 (~60mOD) and Knocknabrona, Upper Dangan, Ch. 7+900 (~75mOD).

In Section 2 (Ch. 8+850 to Ch. 9+500) the underlying bedrock changes from Granite to Limestone at approximately Ch. 8+880. Within this section the ground level reduces from West to East from ~30mOD to ~22mOD towards the western bank of the River Corrib.

On crossing the River Corrib into Section 3 and 4 (Ch. 9+500 to Ch. 17+500), the topography in the eastern area is undulating.

The area around the River Corrib is relatively flat ~8mOD, rises eastwards to ~20mOD in Menlough and further rising to ~40mOD in Coolagh, Menlough directly west of Lackagh Quarry. The highest existing point in Sections 3 and 4 of the proposed road development is at Ballybrit (~60m OD) with low points at Lackagh Quarry (~15mOD) and the N83 Tuam Road Junction (~18mOD) at Twomileditch.

The underlying Limestone in Sections 2, 3 and 4 is known to contain karst features including surface features such as springs, turloughs and swallow holes which are present east of the River Corrib. Limestone pavement [1] is also common throughout the area, east of River Corrib.

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.

5.4.2.2 Hydrogeology

This section of the report presents an overview of the existing hydrogeological environment which is discussed in detail in Chapter 10 of GCOB-4.04.019_Environmental Impact Assessment (EIA) Report.

The hydrogeological study area is divided into two main areas based on the contrasting aquifer properties for the two main geological rock types in the region. The bedrock hydrogeology 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 Coast Road 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

The Galway Granite Batholith encompasses Section 1 of the proposed road development, whilst the Visean Undifferentiated Limestone encompasses Section 2, 3 and 4.

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. The overburden overlying the granite is generally less than 3m thick and comprises of low permeability glacial tills.

The groundwater table remains close to the surface and generally follows the topography across the Galway Granite Batholith. With groundwater contours generally following topography, lowering towards the coast and the River Corrib. The proposed road development either traverses or is adjacent to two groundwater bodies within the GSI database, namely the Spiddal and Maam-Clonbur groundwater bodies (GWB) in the Galway Granite Batholith. The groundwater divide between the GWB matches the topographic watershed between surface water draining to Galway Bay and surface water draining to the River Corrib.

The groundwater divide between the GWB matches the topographic watershed between surface water draining to Galway Bay and surface water draining to the River Corrib.

The GSI classify the Visean Undifferentiated Limestone as being a regionally important karstified aquifer (Rk), which is further characterised as being 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.

The Visean Undifferentiated Limestone is divided into groundwater bodies and these comprise of:

- Ross Lake
- GWDTE Lough Corrib Fen 1 (Menlough)
- GWDTE Lough Corrib Fen 2
- GWDTE Lough Corrib Fen 3 & 4
- Clarinbridge
- Clare-Corrib

There are three groundwater divides within the Visean Undifferentiated Limestone Aquifer that are crossed by the proposed road development and these comprise of the following locations:

- The River Corrib which forms a groundwater divide between the Ross Lake GWB and the Lough Corrib Fen 1 (Menlough) GWB
- A groundwater ridge between Lough Corrib Fen 1 (Menlough) GWB and the Clare Corrib GWB that lies c.200m to the west of Lackagh Quarry
- A groundwater divide at the N83 Tuam Road, which separates the Clare Corrib GWB and the Clarinbridge GWB

The GSI data shows that the limestone bedrock is generally at or close to surface, but that in a number of locations that deep subsoil is present. At Coolagh Lake, Ballindooley Lough, the Terryland River and the Tuam Road are a series of buried valleys that focus towards the River Corrib.

Bedrock is particularly deeply buried in these features (up to 106m below ground level). The groundwater bodies are presented in Figures 10.2.001 and 10.2.002 in the EIA Report.

5.4.2.3 Superficial Deposits

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 more detailed examination of the superficial deposits are provided in **Section 5.5** Ground Conditions. The following description provides an overview of the region.

Section 1: Chainage 0+000 to 8+850

Section 1 consists generally of Peat over a mixture of granular Glacial Deposits and highly weathered Granite.

Section 2: Chainage 8+850 to 9+500

Section 2 is comprised of soft to firm sandy, gravelly Clay mixed with coarse Gravel over weathered Limestone.

Section 3: Chainage 9+500 to 14+150 and Area 4: Chainage 14+150 to 17+500

East of the River Corrib, the study area typically consists of Glacial Till derived from Limestone, over weathered Limestone. Instances of a Palaeolandscape Fill were uncovered in various low-lying areas within the study area in Menlough, Coolough, Castlegar and Terryland. In the area west of Lackagh Quarry an organic / non-organic Clay was encountered in two boreholes at depth.

5.4.2.4 Bedrock Geology

Bedrock geology was established based on the Bedrock Geology 1:100,000 online mapping as provided by the Geological Survey of Ireland, and relevant ground investigation along the route of the proposed road development.

A more detailed examination of the bedrock geology is provided in **Section 5.5**. The following description provides an overview of the region.

Section 1: Chainage 0+000 to 8+850

This section is comprised of various rock masses of the Galway Granite Batholith, which consists of a number of distinct granite intrusions which only have three mineral assemblages and is faulted into three main parts by the Shannawona north northeast trending faults and the Bearna northwest trending faults. The Bearna Fault runs approximately through the centre of Section 1 at Aille / Ballard. Faulting in the Galway Granite Batholith was not confirmed in intrusive investigation.

Therefore, reference to such faulting and the location of the structural geology is based purely on the indicative locations provided by the GSI.

The principal mass is a coarse grained, pink, phenocrystic K-feldspar Granite which well describes the Errisbeg Townland Granite and Megacrystic-Porphyritic Granite. The Megacrystic-Porphyritic Granite occurs west of the Bearna Fault while the Errisbeg Townland Granite occurs east of the fault.

Crossing almost all of these intrusions are late stage felsite, quartz porphyry and granite porphyry dykes, which are all part of the same magmatic episode.

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 occurs at the outer periphery of the Errisbeg Townland Granite, against the country rock (Lower Carboniferous Visean Limestone) and is considered to be the most fractionated of all the granites in the batholith.

Section 2: Chainage 8+850 to 9+500

The area of Visean Limestones between the western shore of the River Corrib and the fault bounding the pre-Carboniferous rocks to the west was originally mapped by C.V. MacDermot in the late 1960’s and early 1970’s. This unconformity line / fault is still considered valid. Intrusive investigation and geophysical investigation confirmed the high likelihood that the change in rock type occurs at Ch. 8+880.

Section 3 and 4: Chainage 9+500 to 17+500

East of the river consists of Lower Carboniferous (Visean) Limestone. Very limited information exists for the Visean Limestone west and east of Lough Corrib and is therefore described as an undifferentiated Limestone. The exploratory descriptions are not homogenous and therefore no trend or isolated areas of distinct characteristics have been observed. Where the palaeolandscape is present the Limestone bedrock was encountered at depths deeper than elsewhere within the study area.

Some argillaceous (clayey) material was recorded in the boreholes. The nature of the Limestone strongly influences its susceptibility to karstification. Purer Limestones (>90% calcite) are more susceptible than impure (shaly / argillaceous) Limestones.

5.4.2.5 Contaminated Ground

No known areas of contaminated ground were identified. Various sources of information were consulted in the assessment:

- Co-ordinated Information of the Environment (CORINE) land cover mapping
- Teagasc soil map
- EPA
- Ground investigation data

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 according to the CORINE land cover mapping. The risk of contamination is low as these sites operate within the EPA Industrial Emissions (IE) licence framework and due to the regulated nature of their activities.

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. There are no sites within the study area that have been granted a waste water discharge licence.

Made Ground is defined as soil which has been altered in some way by human activity (imported and placed in-situ). Made Ground has been observed along the proposed road development in the form of inclusions of metal, glass, copper piping and ceramic piping. All location of Made Ground are presented **Section 5.5.1**.

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 comprising of artificial surfaces.

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+850

No known area of contaminated ground was identified.

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+850 to 9+500

No known area of contaminated ground was 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+500 to 14+150

No known area of contaminated ground was identified.

CORINE and Teagasc subsoil mapping highlight areas of artificial surfaces due to residential dwellings, commercial properties and industrial usage.

Section 4: Chainage 14+150 to 17+500

No known area of contaminated ground was identified.

CORINE and Teagasc subsoil mapping highlight areas of artificial surfaces due to residential dwellings, commercial properties, sport and leisure facilities and industrial usage.

5.4.2.6 Mineral / Historical Resources

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 sub-surface cavities.

Historical quarries and pits were identified within the vicinity of the proposed road development. One large inactive quarry, Lackagh Quarry is located in **Section 3**, at Ch. 11+430 to Ch. 11+720.

5.5 Ground Conditions

The ground conditions across the proposed road development generally consist of Glacial Deposits derived from the underlying bedrock. Isolated instances of Peat and Alluvium are also present.

Generally the rock is Granite to the west of the River Corrib and Limestone to the east. The Limestone is also present along the western bank of the River Corrib.

A conceptual site model was developed based on the ground investigation data. The model includes the factual data across the proposed road development that was gathered during the ground investigations. The ground conditions are presented in Drawings **GCOB-600-D-201** to **212** in **Volume 2** in plan and profile format with the profile illustrating the existing and proposed ground levels, earthwork sections, local ground investigation logs, geophysical data and the minimum and maximum groundwater levels along the centre-line of the proposed road development. The earthworks areas are summarised in tabular format in **Appendix A.5.2**.

The ground conditions were assessed using various sources of information, such as exploratory log descriptions, laboratory testing, site investigation monitoring and observations, photographic evidence and historical data. The combination of all these sources provided the most representative understanding of the ground conditions.

The preliminary ground investigation, commissioned for the project, was conducted between January to April 2016. Heavy rainfall occurred prior to and during the investigation. The overburden is moisture sensitive and is like to vary with seasons.

The overburden / subsoils in the region is identified as mainly those that are derived from Granite or Limestone bedrock both of which have a significant percentage of granular parent material. However, there is also a third category of subsoil, which is dominated by fine sediment, specifically clay. The clay subsoils are located in the Limestone bedrock area but more specifically at locations where palaeolandscapes or palaeokarst was identified, such as to the west of Lackagh Quarry, Ballindooley and Castlegar. As the clay subsoils generally do not have lithic clasts present, the parent material was not identified and in this report they are simply referred to as being Paleokarst Fill.

The subsoil and bedrock formations present along the proposed road development are provided in **Table 5.2** and discussed in the following subsections.

Table 5.2: Overburden and Rock Type

Material Type	Description of Lithology
Topsoil / Made Ground	Mixed
Peat	Quaternary formation
Alluvium	Recent alluvial deposits
Glacial Gravel (TGr)	Granular glacial deposits derived from Granite
Glacial Till (TGr)	Cohesive glacial deposits derived from Granite
Glacial Gravel (TLs)	Granular glacial deposits derived from Limestone
Glacial Till (TLs)	Cohesive glacial deposits derived from Limestone
Paleokarst Fill	Subsoil dominated by fine sediments
Granite	Ordovician to Devonian igneous rock
Limestone	Undifferentiated Carboniferous rock

Each of the materials provided in **Table 5.2** are described in **Sections 5.5.1** to **5.5.10** (where appropriate) under the following aspects:

- **Location**
- **Classification** – General classification testing such as Natural Moisture Content (NMC), Particle Size Distribution (PSD), Atterberg limits and organic content were consulted in establishing the classification of the material
- **Earthworks Acceptability Criteria** – Based on published guidance, the following material constituents were used to assess the material acceptability

  Moisture Condition Value (MCV) - Based on Rutty & Johnston (2012), an MCV of 7 was assumed as the lower bound value, which equates to an undrained shear strength of approximately 50kPa for silts

  California Bearing Ratio (CBR) - Based on published guidance such as the UK IAN 73/06, a CBR of 2.5% is often selected as the lower bound limit, as subgrade with values below this are deemed too soft/unacceptable

  Optimum Moisture Content (OMC) is a location and material sensitive constituent
- **Permeability** – Based on permeability ranges for subsoil overburden provided by the Geological Survey of Ireland (GSI) and an assessment of available PSD data using the Hazen methodology

  The GSI identify three permeability ranges, namely:

  - high (< 8% fines, >$1x10^{-4}$ m/s)
  - moderate (<12% clay <35% fines, 1×10^{-4} to 1×10^{-8} m/s)
  - low (>14% clay or >50% fines, < 1×10^{-8} m/s)

  The Hazen equation was also used to calculate permeability in samples with a D10 value i.e. the grain size for which only 10% of the material distribution is finer.

  $$\text{Permeability } k = C\,(D_{10})^2$$

There is a limitation on the Hazen methodology as it is only suitable where the D10 lies between 0.1 and 3mm (fine sand to gravel). The constant C is given a value of 0.01, which is a calibration factor derived by Preene et al. (2016)

5.5.1 Topsoil/Made Ground

Topsoil was encountered in the majority of areas of the proposed road development, while on occasion Made Ground comprising of Glacial Deposits mixed with concrete, timber, metal, glass, copper piping and ceramic piping were encountered.

Made Ground may either be deemed non-hazardous or hazardous material. Made Ground will not comply with the permitted constituents and material properties of Table 6/1 of TII SRW Series 600 Earthworks. Material deemed non-hazardous shall be classified as Class U1 unacceptable material while hazardous material shall be classified as Class U2 unacceptable material.

During construction, storage and handling of topsoil and made ground shall comply with the relevant clauses in TII SRW Series 600 Earthworks.

5.5.1.1 Location

The location of the Topsoil can be assumed to be widespread across the proposed road development.

The location of the Made Ground is provided in **Table 5.3**. These locations are based on Made Ground deposits encountered in the preliminary and historical ground investigations. The CORINE land mapping and Teagasc subsoil mapping were also reviewed for areas consisting of artificial and Made Ground. Presented in the table below are the findings of the intrusive investigation.

Table 5.3: Location of Made Ground

Earthwork Section	Chainage From	Chainage To	Townland	Max Recorded Depth (m)	Total approx. Length (m)	Description
Section 1 EW01	0+000	0+500	Na Foraí Maola	1.3	100	Cobbles and boulders with silts, sands and gravels with many rootlets
Section 1 EW02	0+500	2+770	Na Foraí Maola to An Chloch Scoilte	-	650	Aerial photography and site walkovers indicate residential properties
Section 1 EW05	3+900	4+430	Aille	-	50	Aerial photography and site walkovers indicate farmland and residential properties
Section 1 EW08	5+600	7+150	Ballymoneen to Letteragh	1.3	50	Very fibrous peat mixed with concrete, timber,

Earthwork Section	Chainage From	Chainage To	Townland	Max Recorded Depth (m)	Total approx. Length (m)	Description
						metal, glass, copper and ceramic piping
Section 1 EW13	8+300	8+850	Dangan	-	540	Aerial photography and site walkovers indicate residential properties
Section 2 EW14	8+850	9+300	Dangan to River Corrib	5.3	340	Leisure facilities with intrusive investigation citing clause 804 material
Section 3 EW16	9+500	10+100	Menlough	0.7	100	Possible along eastern river bank
Section 3 EW21	11+420	11+720	Coolough	-	290	Disused quarry with potential made / disposed material
Section 3 EW23	11+920	12+190	Ballindooley	1.6	250	Gravel with concrete, red brick, ceramic pipe, timber, roof slate, plastic and possible bitumen
Section 3 EW26	12+920	13+050	Castlegar	-	120	Aerial photography and site walkovers indicate residential properties
Section 3 EW27	13+050	13+650	Castlegar	-	50	Aerial photography and site walkovers indicate residential properties
Section 3 EW28	13+650	14+150	N83 Tuam Road	-	150	Aerial photography and site walkovers indicate commercial and residential properties
Section 4 EW30	14+450	14+950	Ballybrit	0.8	150	Aerial photography and site walkovers indicate industrial site / complex
Section 4 EW31	14+950	15+190	Galway Racecourse	-	230	Aerial photography and site walkovers indicate industrial site / complex
Section 4 EW33	15+500	16+200	Briarhill	0.3	450	Aerial photography and site walkovers indicate industrial site / complex
Section 4 EW35	16+900	17+540	Ardaun, Coolagh	-	580	Existing road network

5.5.2 Peat

The proposed road development traverses through areas of Peat. Peat deposits are very soft to soft dark brown to black amorphous to fibrous.

Teagasc subsoil mapping indicates that the Peat is part of cutover and blanket bog.

5.5.2.1 Location

The location of the material class is provided in **Table 5.4**. The Von Post classification is provided in the Peat description where available. Instances of peaty Topsoil was logged in certain exploratory locations. However, this denoted a limited to very thin layer of Peat and therefore is not included in the locations provided.

The approximate lengths provided are based on aerial photography, site walkovers and intrusive investigations.

Table 5.4: Location of Peat

Earthwork Section	Chainage From	Chainage To	Townland	Max Recorded Depth	Total approx. Length (m)	Description
Section 1 EW01	0+000	0+500	Na Foraí Maola	0.6	200	Very soft dark fibrous Peat H5, B3, F3, R2, W0, N1
Section 1 EW02	0+500	2+770	Na Foraí Maola to An Chloch Scoilte	1.1	910	Soft spongy dark brown to black fibrous Peat
Section 1 EW03	2+770	3+100	Ballard West	0.7	130	Soft black amorphous Peat
Section 1 EW04	3+100	3+900	Ballard	0.4	680	Very soft dark brown Peat
Section 1 EW05	3+900	4+430	Aille	2.2	100	Very soft to soft dark brown amorphous Peat H5, B2, F3, R2, W0, N0
Section 1 EW06	4+430	5+250	Cappagh	1.3	490	Soft black amorphous Peat
Section 1 EW08	5+600	7+150	Ballymoneen to Letteragh	1.8	530	Soft brown pseudo fibrous Peat
Section 1 EW09	7+150	7+450	Knocknafroska / Knocknabrona	0.3	120	Peat
Section 1 EW10	7+450	7+750	Knocknafroska / Knocknabrona	0.5	120	Soft black Peat
Section 1 EW11	7+750	8+150	Knocknafroska / Knocknabrona	0.5	370	Soft black Peat
Section 3 EW16	9+500	10+100	Menlough	3	70	Soft light brown fibrous Peat

Earthwork Section	Chainage From	Chainage To	Townland	Max Recorded Depth	Total approx. Length (m)	Description
Section 3 EW24	12+190	12+500	Ballindooley	1.1	100	Firm dark brown spongy to fibrous Peat
N59 Link	0+000	2+170	Letteragh	0.5	900	Soft to firm brown/black fibrous Peat

5.5.2.2 Classification

Laboratory tests were conducted on samples at various depths up to 1.5m below ground level. The maximum depth of Peat recorded along the proposed road development was 4.5m below ground level. The NMC values from 40 samples exhibit a range between 88 to 970% as provided in **Appendix A.5.4**, **Figure 5.01**. The derived median value is equal to 263%.

The degree of humification ranges from 5 to 6 and is based on the available Von Post classification. This corresponds to a moderate to moderately strong decomposition, with considerable amorphous material with a recognisable to indistinct plant structure.

The water content is classified as dry to medium with up to 1000% NMC in the wettest samples. This corresponds well with the NMC samples taken across the development.

The organic content of the Peat was determined based on loss on ignition. Values range from 37 to 84%, with the mean value equal to 68%, the data is presented in **Appendix A.5.4**, **Figure 5.02**.

Values of pH were recorded in the Peat and range from 5.5 to 7.1, with the mean value equal to 6.2, as presented in **Appendix A.5.4**, **Figure 5.03**.

5.5.3 Alluvium

Alluvial deposits have a variable composition ranging from silts to coarse gravels. Teagasc subsoil mapping has indicated the location of where Alluvium is anticipated.

5.5.3.1 Location

The location of the material class is provided in **Table 5.5**.

Table 5.5: Location of Alluvium

Earthwork Section	Chainage From	Chainage To	Townland	Max Recorded Depth	Total approx. Length (m)	Description
Section 1 EW05	3+900	4+430	Aille	-	100	Stream poses the possibility of Alluvium
Section 2 EW15	9+300	9+500	River Corrib	3.0	290	Mixture of soft / loose Silt / Gravel adjacent to major water course
Section 3 EW16	9+500	10+100	Menlough	0.7	100	Soft sandy gravelly Silt
Section 3 EW17	10+100	10+430	Menlough	1.6	30	Soft slightly sandy gravelly Silt

5.5.4 Glacial Gravel (derived from Granite)

For areas of the proposed road development underlain by Granite, much of the overburden consists of completely weathered or disintegrated Granite resulting in granular deposits mixed with Granite cobbles.

The material is typically described as a silty very sandy Gravel. Occasionally it is also described as slightly silty sandy Gravel. The deposits often include cobbles of Granite and occasional boulders.

5.5.4.1 Location

The location of the material class is provided in **Table 5.6**.

Table 5.6: Location of Glacial Gravel derived from Granite

Earthworks Section	Chainage From	Chainage To	Townland Name	Description
Section 1 EW01	0+000	0+500	No Foraí Maola	Very sandy Gravel
Section 1 EW02	0+500	2+770	No Foraí Maola to An Chloch Scoilte	Slightly silty sandy Gravel mixed with cohesive Glacial Till deposits on occasion
Section 1 EW03 - 10	2+820	8+850	An Chloch Scoilte	Slightly silty very sandy Gravel with isolated mixtures of Glacial Till
N59 Link	0+000	2+170	Letteragh	Very sandy Gravel with isolated mixtures of Glacial Till

5.5.4.2 Classification

Laboratory tests were conducted on samples at various depths up to 3.0m below ground level. The NMC values from 73 samples exhibit a range between 4.3 and 54% as provided in **Appendix A.5.4**, **Figure 5.04**. The derived median value is equal to 15%.

The PSD curves for the material generally indicates a well graded granular material, with 0 to 15% Silt, 5 to 54% Sand and 31 to 85% Gravel. The results of the PSD curves are provided in **Appendix A.5.4**, **Figure 5.05**.

5.5.4.3 Earthworks Acceptability Criteria

The NMC of the Glacial Gravel decreases with depth and is indicated to be higher in the west than in the east, as per **Appendix A.5.4**, **Figure 5.04**.

A total of five compaction tests were conducted on the Glacial Gravel. The results, as shown on **Appendix A.5.4**, **Figure 5.06**, show the range of OMC from 10 to 16%. The results indicate that the in situ material is predominantly wet of optimum, with the deviation from the optimum indicated to decrease from west to east in Section 1.

The trend lines of four CBR results were plotted and are provided in **Appendix A.5.4**, **Figure 5.07**. Results indicate that a CBR of 2.5% can only be achieved with a NMC of 13% or less in the west of Section 1. However, in the east of Section 1 the trend line indicates that a CBR of 2.5% can be achieved with a NMC of 45% or less.

Trend provided or indicated may fluctuate and change with additional testing.

5.5.4.4 Permeability

A total of 41 PSD curves of Glacial Gravel derived from Granite were analysed. All of the samples had less than 15% fine material and were not sieved beyond the 0.063mm diameter to test for Silt and Clay material content.

The GSI methodology suggests:

- None of the samples are estimated to have low permeability
- 34% of samples were estimated to be of moderate permeability due to containing less than 35% fine material i.e. permeability ranging between 1×10^{-4} and 1×10^{-8} m/s
- 66% of samples were estimated to be of high permeability due to containing less than 8% fine material i.e. $>1 \times 10^{-4}$ m/s

The PSD curves for the Glacial Gravel derived from Granite were analysed using the Hazen method as described above. Samples in which the D_{10} value was less than 0.1mm or greater than 3mm were dismissed. Using a C value of 0.01 (Preene et al, 2016), the resultant k values ranged from 4.00×10^{-4} to 2.35×10^{-2} m/s, which based on the GSI classification are considered a high permeability.

These samples had an average permeability of 4.46×10^{-3} m/s and a median permeability of 1.85×10^{-3} m/s.

Results from the Hazen analysis and the GSI methodology of estimating permeability correspond with one another.

5.5.5 Glacial Till (derived from Granite)

Isolated instances of cohesive Glacial Deposits were identified along Section 1 of the proposed road development.

The material is typically described as gravelly sandy Silt with some cobbles and boulders of Granite.

5.5.5.1 Location

The location of the material class is provided in **Table 5.7**. There are isolated instances of Glacial Till throughout Section 1, however they are generally very shallow and very thin. The more pronounced and evident instances are provided in the table below.

Table 5.7: Location of Glacial Till derived from Granite

Earthworks Section	Chainage From	Chainage To	Townland Name	Description
Section 1 EW01	0+000	0+500	No Foraí Maola	Mixture of gravelly Silt with granular deposits
Section 1 EW02	0+500	2+770	No Foraí Maola to An Chloch Scoilte	Sandy gravelly Silt mixed with granular till deposits on occasion
Section 1 EW05	3+900	4+430	Aille	Mixture of gravelly Silt with granular deposits

5.5.5.2 Classification

Laboratory tests were conducted on samples at various depths up to 1.6m below ground level.

The NMC values from 24 samples exhibit a range from 15 to 91% as provided in **Appendix A.5.4**, **Figure 5.08**. The derived median value is equal to 30%.

The Atterberg limits derived from the samples collected show that the Glacial Till is a Clay or Silt with a low to extremely high plasticity as shown in **Appendix A.5.4**, **Figure 5.09**. Plasticity index values range from 10% to 56% and a derived median value of 25%. Liquid limit from four samples range from 32% to 132% with a derived median value of 101%.

PSD curves for the material generally indicates a well graded material with between 19 to 40% Silt, 10 to 47% Sand and 21 to 64% Gravel. The results of PSD curves are provided in **Appendix A.5.4**, **Figure 5.10**.

5.5.5.3 Earthworks Acceptability Criteria

The NMC of the Glacial Till decreases with depth as shown on **Appendix A.5.4**, **Figure 5.08**.

An MCV test was conducted on one sample of the material. Based on the available data, as shown in **Appendix A.5.4**, **Figure 5.11**, a NMC of less than 14% is required to achieve an MCV of 7.

Some of the material tested is indicated to have extremely high plasticity. Maximum liquid limit values of 132% were recorded, with three of the four samples tested showing liquid limit values greater than 80%. According to TII SRW Series 600 Earthworks, material having a liquid limit determined in accordance with BS 1377: Part 2 exceeding 80% is classified as U1 unacceptable material.

Trend provided or indicated may fluctuate and change with additional testing.

5.5.5.4 Permeability

A total of 6 PSD curves of Glacial Till derived from granite were analysed. In relation to the samples tested, two were sieved beyond 0.063mm diameter and down to 0.002mm diameter to test for Silt and Clay material content.

The GSI methodology suggests:

- All soil samples have moderate permeability due to the samples containing less than 12% clay and / or less than 35% fine material i.e. ranging between 1 x 10^{-4} to 1 x 10^{-8} m/s

5.5.6 Glacial Gravel (derived from Limestone)

Very granular Glacial Deposits were encountered in isolated or cluster locations from Section 2 to 4 of the proposed road development. The material has a wide range of description from coarse Gravel to fine Sand. The majority of the Glacial Gravel can be described as silty sandy Gravel or silty gravelly Sand.

Many of the locations identified coincide with the location of the paleokarst discovered in the region. The locations of paleokarst and its associated fill material is further discussed in **Section 5.5.8**.

5.5.6.1 Location

The location of the material class is provided in **Table 5.8**.

Table 5.8: Location of Glacial Gravel derived from Limestone

Earthworks Section	Chainage From	Chainage To	Townland Name	Description
Section 2 EW14 - 16	9+150	9+600	River Corrib	Sandy fine to coarse Gravel Very coarse Gravel directly adjacent to River Corrib

Earthworks Section	Chainage From	Chainage To	Townland Name	Description
Section 3 EW17 - 18	10+300	10+600	Menlough	Slightly sandy fine to coarse Gravel
Section 3 EW19	10+950	11+100	Menlough	Very gravelly Sand becoming very sandy Gravel
Section 3 EW22 - 23	11+850	12+100	Ballindooley	Typically very sandy Gravel

5.5.6.2 Classification

Laboratory tests were conducted on samples of material at various depths up to 3.5m below ground level. The NMC values from 20 samples exhibit a range from 2.3 to 34% as shown in **Appendix A.5.4**, **Figure 5.12**. The derived median value is equal to 7.9%.

The PSD curves for the material generally indicates a well graded granular material, with 1 to 15% Silt, 2 to 70% Sand and 16 to 95% Gravel. The results of the PSD curves are provided in **Appendix A.5.4**, **Figure 5.13**.

5.5.6.3 Earthworks Acceptability Criteria

A number of compaction tests were conducted throughout Section 2 to 4 however the majority of these were conducted in material with a much higher fines content. One compaction test was conducted on the Glacial Gravel. The result, as indicated in **Appendix A.5.4**, **Figure 5.14**, shows an OMC of 20%. The result indicates that the in situ material is wet of optimum.

A total of one CBR test was also conducted in the Glacial Gravel. A NMC of 22% or less is required to achieve a CBR of 2.5% according to the test, as indicated in **Appendix A.5.4**, **Figure 5.15**.

Trend provided or indicated may fluctuate and change with additional testing.

5.5.6.4 Permeability

A total of 14 PSD curves of the Glacial Gravel derived from Limestone were analysed. In relation to the samples tested, one had greater than 15% fines and was sieved beyond 0.063mm diameter and down to 0.002mm diameter to test for Silt and Clay material content.

The GSI methodology suggests:

- None of the soils are estimated to have low permeability
- 71% of samples were estimated to be of moderate permeability due to containing less than 35% fine material i.e. permeability ranging between 1 x 10^{-4} and 1 x 10^{-8} m/s
- 29% of samples were estimated to be of high permeability due to containing less than 8% fine material i.e. >1 x 10^{-4} m/s

5.5.7 Glacial Till (derived from Limestone)

The predominant material found from Section 2 to 4 is a well graded cohesive Glacial Deposit derived from Limestone. Some isolated instances of very sandy or very gravelly Glacial Till was encountered. However, the material is typically described as a sandy gravelly Silt or Clay, with Atterberg limits on the material tested indicating the material to be predominantly a Clay.

5.5.7.1 Location

The location of the material class is provided in **Table 5.9**.

Table 5.9: Location of Glacial Till derived from Limestone

Earthwork Section	Chainage From	Chainage To	Townland Name	Description
Section 2 EW14	8+850	9+300	Dangan to River Corrib	Soft to firm slightly sandy gravelly Clay with a low to medium limestone cobble and boulder content
Section 2 EW15	9+300	9+500	River Corrib	Soft to firm slightly sandy gravelly Clay with a low to medium limestone cobble and boulder content
Section 3 EW16	9+500	10+100	Menlough	Soft to very stiff slightly sandy slightly gravelly Clay with a medium limestone cobble and boulder content
Section 3 EW17	10+100	10+430	Menlough	Soft to stiff slightly sandy slightly gravelly Clay with a medium limestone cobble and boulder content
Section 3 EW18	10+430	10+810	Menlough	Soft to firm slightly sandy slightly gravelly to sandy gravelly Clay with low to medium limestone cobbles and boulders
Section 3 EW19	10+810	11+140	Coolough	Firm slightly sandy gravelly Clay with some cobbles and boulders of limestone
Section 3 EW20	11+140	11+420	Coolough	Firm slightly sandy gravelly Clay with some cobbles and boulders of limestone
Section 3 EW22	11+720	11+920	Ballindooley	Sandy gravelly Silt / Clay
Section 3 EW23	11+920	12+190	Ballindooley	Firm very sandy very gravelly Clay with low to medium limestone cobbles and boulders
Section 3 EW24	12+190	12+500	Ballindooley	Firm sandy slightly gravelly to slightly sandy slightly gravelly Clay with low to medium limestone cobbles and boulders

Earthwork Section	Chainage From	Chainage To	Townland Name	Description
Section 3 EW25	12+500	12+920	Castlegar	Firm to very stiff slightly sandy slightly gravelly to slightly sandy gravelly Clay with occasional cobbles and boulders of limestone
Section 3 EW26	12+920	13+050	Castlegar	Firm to stiff slightly sandy slightly gravelly Clay with occasional cobbles and boulders of limestone
Section 3 EW27	13+050	13+650	Castlegar	Firm slightly sandy gravelly Silt / Clay with low to medium cobble and boulder content of limestone
Section 3 EW28	13+650	14+150	N83 Tuam Road	Soft to firm slightly sandy slightly gravelly to slightly sandy gravelly Silt / Clay with occasional to many cobbles and boulders of limestone
Section 4 EW29	14+150	14+450	Ballybrit	Soft to very stiff slightly sandy slightly gravelly Clay with low to medium cobble and boulder limestone content
Section 4 EW30	14+450	14+950	Ballybrit	Soft to very stiff slightly sandy slightly gravelly Clay with low to medium cobble and boulder limestone content
Section 4 EW31	14+950	15+190	Galway Racecourse	Soft to very stiff slightly sandy slightly gravelly Clay with low to medium cobble and boulder limestone content
Section 4 EW32	15+190	15+500	Ballybrit	Firm to stiff slightly sandy gravelly Clay with low to medium cobble and boulder limestone content
Section 4 EW33	15+500	16+200	Briarhill	Soft to firm slightly sandy gravelly Clay / Silt with low to medium cobble and boulder limestone content
Section 4 EW34	16+200	16+900	Briarhill	Based on the Glacial Till encountered along the proposed road development the material is likely to be a slightly sandy gravelly Clay
Section 4 EW35	16+900	17+540	Ardaun, Coolagh	Based on the Glacial Till encountered along the proposed road development the material is likely to be a slightly sandy gravelly Clay

5.5.7.2 Classification

Laboratory testing was conducted on samples at various depths up to 21.5m below ground level. The NMC values for 172 samples show a range between 5.3 to 47% as provided in **Appendix A.5.4**, **Figure 5.16**. The median value is equal to 11%.

The Atterberg limits derived from the samples collected show that the Glacial Till is predominantly a Clay of low to intermediate plasticity. Silts of intermediate plasticity were encountered in Menlough and west of Lackagh Quarry. The data is presented in **Appendix A.5.4**, **Figure 5.17**.

PSD curves for the material generally indicates a well graded material with between 16 to 58% Silt, 10 to 66% Sand and 2 to 72% Gravel. The results of the PSD curves are provided in **Appendix A.5.4**, **Figure 5.18**.

5.5.7.3 Earthworks Acceptability Criteria

The NMC data suggests that there is a general decrease with depth, as presented in **Appendix A.5.4**, **Figure 5.16**.

A total of 18 MCV tests were conducted on the Glacial Till material derived from Limestone. Three results were discounted as they are incorrect and one additional result was ignored as it is not consistent with the behaviour of the other samples tested. Based on the available data, as shown in **Appendix A.5.4**, **Figure 5.19**, a range of NMC exists for achieving an MCV of 7. The range is between 7 to 16.5%.

Of the 14 samples, seven samples achieve an MCV of 7 at a moisture content of less than 9.5%. Based on the available information, rock is anticipated to be shallow and therefore a limited quantity of Glacial Till from this location shall be extracted.

Maximum liquid limit recorded for the material is 49%, meaning that all the material tested is low to intermediate plasticity. Nine of the samples tested are described as Silt, which means that approximately 75% of the samples tested behave as a Clay. This is shown in **Appendix A.5.4**, **Figure 5.17**.

Six compaction tests were also conducted in the Glacial Till. Five of the samples are indicated to be wet of optimum with four of the samples just west of optimum i.e. within 4% of the optimum. The results are shown in **Appendix A.5.4**, **Figure 5.20**.

Trend provided or indicated may fluctuate and change with additional testing.

5.5.7.4 Permeability

A total of 94 samples of Glacial Till derived from Limestone were analysed. Within the dataset, 68 samples were tested for Silt and Clay material content up to 0.002mm diameter, all other samples were only sieved up to 0.063mm diameter.

Based on the GSI methodology:

- None of the soils are estimated to have high permeability as each sample contained more than 8% fine material

- 60% of samples were estimated to be of moderate permeability due to containing less than 12% clay and/ or less than 35% fine material i.e. ranging between 1 x 10^{-4} to 1 x10^{-8} m/s
- 21% of samples were estimated to be of low permeability due to containing more than 14% clay material and/ or more than 50% fine material i.e. permeability of less than 1 x 10^{-8} m/s
- 19% of samples were estimated to be low to moderate permeability due to containing between 35% and 50% fine material

5.5.8 Palaeokarst Fill

Buried valleys with Silt and Clay infilling are situated at certain locations in the east of Galway City. These are identified as palaeolandscape or palaeokarst features. These are significantly deep features with low permeability infill.

Typically, deposits with characteristics of Glacial Till are present above and contrast with the soft Silt / Clay infilling within the buried channel. The change in material characteristics was captured in ground investigation in Menlough and is assumed to occur between 13 to 22m below ground level. However, this change is characteristic and may be deeper in other areas.

5.5.8.1 Location

The location of the Palaeokarst fill material class is provided in **Table 5.10**.

Table 5.10: Location of Palaeolandscape Fill

Earthworks Section	Chainage From	Chainage To	Townland Name	Description
Section 3 EW16	9+800	10+000	Menlough	Palaeokarst Fill
Section 3 EW18 - 20	10+700	11+200	Coolough	Palaeokarst Fill
Section 3 EW23	11+950	12+250	Ballindooley	Palaeokarst Fill
Section 3 EW25 - 27	12+800	13+100	Castlegar	Palaeokarst Fill
Section 3 EW28	13+650	14+150	N83 Tuam Road	Palaeokarst Fill

5.5.8.2 Classification

Laboratory tests were conducted on samples at various depths up to 71.6m below ground level. The NMC values from 25 samples exhibit a range between 20 to 38% as provided in **Appendix A.5.4**, **Figure 5.21**. The derived median value is equal to 29%. The insitu conditions are anticipated to be wetter than indicated from the samples tested.

A total of four sets of Atterberg limits were conducted for material with the characteristics of Palaeokarst Fill. Two of the samples taken in Castlegar describe the material as Clay, while sample taken in Menlough describe the material as Silt. The data is presented in **Appendix A.5.4**, **Figure 5.22**.

The PSD curves for the fill material generally indicate a very fine material with between 8 to 91% Silt, 4 to 62% medium/fine Sand, 0 to 30% coarse Sand, 0 to 17% Gravel. The PSD results are provided in **Appendix A.5.4**, **Figure 5.23**. Log descriptions indicate the fill material is anticipated to be a slightly granular Silt or Clay.

5.5.8.3 Earthworks Acceptability Criteria

No earthworks acceptability testing was conducted for the Palaeokarst Fill. However as this material is quite deep and does not occur in the base of any cuttings of the proposed road development, it will not require such an assessment.

5.5.8.4 Permeability

A total of six samples of Clay overburden subsoil was analysed. All of the samples recorded more than 14% Clay and/or more than 50% fine material. Based on the GSI methodology relating PSD to permeability all the Clay subsoil samples record a low permeability classification.

5.5.9 Granite

Granite bedrock is encountered west of the River Corrib. This corresponds to Section 1 of the proposed road development. The bedrock is generally described as Granite which is medium to coarse grained, locally to slightly weathered and very strong.

5.5.9.1 Location

The location of the Granite bedrock is detailed in **Table 5.11**.

Table 5.11: Location of Granite Bedrock

Earthworks Section	Chainage From	Chainage To	Townland Name	Average Depth to Bedrock (m bgl)	Description
Section 1 EW01	0+000	0+500	Na Foraí Maola	1.00	Very strong, thickly to thinly banded, brown pink green mottled, porphyritic, medium to coarse-grained, Granite fresh to locally slightly weathered
Section 1 EW02	0+500	2+770	Na Foraí Maola to An Chloch Scoilte	1.00	Very strong, thickly to thinly banded, brown pink green mottled, porphyritic, medium to

Earthworks Section	Chainage From	Chainage To	Townland Name	Average Depth to Bedrock (m bgl)	Description
					coarse-grained, Granite fresh to locally slightly weathered
Section 1 EW03	2+770	3+100	Ballard West	0.80	Very strong, thickly to thinly banded, brown pink green mottled, porphyritic, medium to coarse-grained, Granite fresh to locally slightly weathered
Section 1 EW04	3+100	3+900	Ballard	0.50	Very strong, thickly to thinly banded, light pink/red/brown/grey/white/orange mottled, porphyritic, medium to coarse-grained, Granite, fresh to locally slightly weathered
Section 1 EW05	3+900	4+430	Aille	1.20	Very strong, thickly to thinly banded, brown/pink/purple/white/green/orange mottled, porphyritic, medium to coarse-grained, Granite fresh to locally slightly weathered
Section 1 EW06	4+430	5+250	Cappagh	1.80	Very strong, thickly to thinly banded, brown/pink/purple/white/green/orange mottled, porphyritic, medium to coarse-grained, Granite fresh to locally slightly weathered
Section 1 EW07	5+250	5+600	Ballyburke	1.20	Very strong, thickly to thinly banded, brown pink green mottled, porphyritic, medium to coarse-grained, Granite, fresh to locally slightly weathered
Section 1 EW08	5+600	7+150	Ballymoneen to Letteragh	1.4	Strong to very strong, thickly to thinly banded, dark brownish purple / dark green mottled, porphyritic, medium to coarse-grained, Granite, fresh to locally slightly weathered
Section 1 EW09	7+150	7+450	Knocknafroska / Knocknabrona	2.8	Very strong, thickly to thinly banded, dark

Earthworks Section	Chainage From	Chainage To	Townland Name	Average Depth to Bedrock (m bgl)	Description
					brownish purple mottled, porphyritic, medium to coarse-grained, Granite, fresh to locally slightly weathered
Section 1 EW10	7+450	7+750	Knocknafroska / Knocknabrona	3.3	Very strong, thickly to thinly banded, dark green mottled, porphyritic, medium to coarse-grained, Granite, fresh to locally slightly weathered
Section 1 EW11	7+750	8+150	Knocknafroska / Knocknabrona	2.4	Very strong, thickly to thinly banded, brown pink green mottled, porphyritic, medium to coarse-grained, Granite, fresh to locally slightly weathered
Section 1 EW12	8+150	8+300	Upper Dangan	2.3	Very strong to strong, thickly to thinly banded, light green/grey/white mottled, porphyritic, medium to coarse-grained, Granite, fresh to locally slightly weathered
Section 1 EW13	8+300	8+850	Dangan	2.8	Very strong to strong, thickly to thinly banded, light green/dark green/grey/white mottled, porphyritic, medium to coarse-grained, Granite, fresh to locally moderately weathered

5.5.9.2 Rock Mass Characteristics

The Total Core Recovery (TCR) reported for 148 samples are plotted against depth (**Appendix A.5.4**, **Figure 5.24**), the values range from 61 to 100%. The majority of the results exhibit a TCR equal to 100%. The recorded TCR value less than 50% is reported as a non – intact zone of possibly weathered rock.

The Rock Quality Designation (RQD) ranges from 0 to 100% (**Appendix A.5.4**, **Figure 5.25**), 70% of the values range from 80 to 100%, indicative of “Good” to “Excellent” quality rock. The RQD values less than 50% are reported as non – intact zones. The median value for RQD of the granite is 90%.

5.5.9.3 Rock Strength

The Unconfined Compressive Strength (UCS) of samples of rock was measured in the laboratory yielding values from 23 to 127MPa. The UCS values are plotted with depth below rockhead level (**Appendix A.5.4**, **Figure 5.26**). While there is no discernable trend with depth, the strength of the rock appears to be decreasing. The majority of the rock tested can be classified as medium strong to strong.

Point Load Tests (PLT) were carried out on rock samples yielding point load strength indices (Is_{50}) of between 0.40 and 9.24. The Is_{50} of the rock samples was plotted on the Franklin et al. (1971) excavatability chart (**Appendix A.5.4**, **Figure 5.27**), indicating that blasting would be required in order to fracture/loosen the in situ material.

5.5.9.4 Earthworks Acceptability Criteria

Laboratory tests were conducted on samples at various depths up to 23.0m below ground level (m bgl). The natural moisture content (NMC) of the 24 samples tested ranges from 0.08 to 0.22% (**Appendix A.5.4**, **Figure 5.28**), with an average value of 0.13%.

The Los Angeles (LA) testing was carried out on one sample of rock yielding a result of from 26. The acceptable upper limit for Class 1C and Class 6 material is a coefficient of 50.

Slake durability testing was carried out on four samples of rock with all test results reported greater than 95% in accordance with the lower acceptability limit for Class 6 material.

It is likely that the majority of the Granite bedrock excavated will be reuseable as Class 1 / Class 6 material, after appropriate processing and subject to confirmatory testing. Note as the available information is limited, it is not possible to carry out a full material acceptability assessment at this phase of Design.

5.5.10 Limestone

Limestone bedrock is encountered east of the River Corrib and on its western bank. This corresponds to Section 2, 3 and 4 of the proposed road development. The bedrock is generally described as Limestone which is slightly to locally weathered, medium strong to very strong.

5.5.10.1 Location

The location of the Limestone bedrock is detailed in **Table 5.12**.

Table 5.12: Location of Limestone

Earthworks Section	Chainage From	Chainage To	Townland Name	Average Depth to Bedrock (m bgl)	Description
Section 2 EW14	8+850	9+300	Dangan to River Corrib	5.20	Medium strong to very strong, thick to thinly bedded, blueish dark grey, fine grained Limestone (locally fossiliferous, localized chert and stylolites), fresh to slightly weathered
Section 3 EW16 – 18	9+500	10+810	Menlough	1.50	Medium strong to very strong, thick to thinly bedded, blueish dark grey, fine grained Limestone (locally fossiliferous, localized chert and stylolites), slightly to locally moderately weathered
Section 3 EW19	10+810	11+030	Coolough	7.9	Strong, fresh, grey medium grained, massive Limestone
Section 3 EW19 - 20	11+030	11+170	Coolough	50.0	[Deep] strong, fresh, grey medium grained, massive Limestone, with isolated laminates of Mudstone
Section 3 EW20	11+170	11+250	Coolough	2.3	Strong, fresh, grey / dark grey, slightly mottled, fine to medium grained, massive Limestone
Section 3 EW20 - 22	11+250	11+790	Coolough	0.0	Limestone pavement and exposed disused quarry
Section 3 EW22 – 24	11+790	12+500	Ballindooley	3.50	Medium strong to very strong, thick to thinly bedded, blueish dark grey, fine grained Limestone (locally fossiliferous,

Earthworks Section	Chainage From	Chainage To	Townland Name	Average Depth to Bedrock (m bgl)	Description
					localized chert and stylolites), slightly to locally moderately weathered
Section 3 EW25 – 27	12+500	13+650	Castlegar	15.80	Medium strong to very strong, thick to thinly bedded, blueish dark grey, fine grained Limestone (locally fossiliferous, localized chert and stylolites), slightly to locally moderately weathered
Section 3 EW28	13+650	14+150	N83 Tuam Road	21.60	Very strong (where competent), medium to thinly bedded, blueish dark grey, fine grained Limestone (locally fossiliferous, localized chert and stylolites), slightly to locally highly weathered
Section 4 EW29 – EW30	14+150	14+950	Ballybrit	4.00	Very strong, thick to thinly bedded, blueish dark grey, fine grained Limestone (locally fossiliferous, localized chert and stylolites), fresh to slightly weathered
Section 4 EW31	14+950	15+190	Galway Racecourse	4.00	Very strong, thick to thinly bedded, blueish dark grey, fine grained Limestone (locally fossiliferous, localized chert and stylolites), fresh to slightly weathered
Section 4 EW32	15+190	15+500	Ballybrit	4.00	Very strong, thick to thinly bedded, blueish dark grey, fine grained Limestone (locally fossiliferous, localized chert and

Earthworks Section	Chainage From	Chainage To	Townland Name	Average Depth to Bedrock (m bgl)	Description
					stylolites), fresh to slightly weathered
Section 4 EW33 – EW34	15+500	16+900	Briarhill	1.90	Medium strong to very strong, thick to thinly bedded, blueish dark grey, fine grained Limestone (locally fossiliferous, localized chert and stylolites), fresh to slightly weathered
Section 4 EW35	16+900	17+540	Ardaun, Coolagh	1.20	Medium strong to very strong, thick to thinly bedded, blueish dark grey, fine grained Limestone (locally fossiliferous, localized chert and stylolites), fresh to slightly weathered

5.5.10.2 Rock Mass Characteristics

The Total Core Recovery (TCR) reported for 333 samples are plotted against depth (**Figure 5.29**), the values range from 0 to 100%. The majority of the results exhibit a TCR equal to 100%. The TCR values less than 50% are reported as non – intact zones with clay – filled fractures and recovery was not possible.

The Rock Quality Designation (RQD) ranges from 0 to 100% (**Appendix A.5.4**, **Figure 5.30**), 50% of the values range from 80 to 100%, indicative of “Good” to “Excellent” quality rock. The RQD values less than 50% are reported as non – intact zones with clay / gravel – filled fractures. The median value for the Limestone RQD is 80%.

5.5.10.3 Rock Strength

The Unconfined Compressive Strength (UCS) of samples of rock was measured in the laboratory yielding values from 17 to 100MPa. The UCS values are plotted with depth below rockhead level (**Appendix A.5.4**, **Figure 5.31**), there is no discernable trend with depth. The majority of the rock tested can be classified as medium strong to strong.

Point Load Tests (PLT) were carried out on rock samples yielding point load strength indices (Is_{50}) of between 1.09 and 7.3. The Is_{50} of the rock samples was plotted on the Franklin et al. (1971) excavatability chart (**Appendix A.5.4**, **Figure 5.32**), indicating that blasting would be required in order to fracture / loosen the in situ material.

5.5.10.4 Earthworks Acceptability Criteria

Laboratory tests were conducted on samples at various depths up to 24.6m below ground level (m bgl). The natural moisture content (NMC) of the 25 samples tested ranges from 0.11 to 0.28% (**Appendix A.5.4**, **Figure 5.33**), with an average value of 0.22%.

The Los Angeles (LA) testing was carried out on four samples of rock yielding results from 27 to 28, with an average of 27.75. The acceptable upper limit for Class 1C and Class 6 material is a coefficient of 50.

Slake durability testing was carried out on four samples of rock with all test results reported greater than 95% in accordance with the lower acceptability limit for Class 6 material.

It is likely that the majority of the Limestone bedrock excavated will be reuseable as Class 1 / Class 6 material after appropriate processing and subject to confirmatory testing. Note as the available information is limited, it is not possible to carry out a full material acceptability assessment at this phase of Design.

5.6 Preliminary Engineering Assessment

This preliminary engineering assessment has been conducted based on the proposed road development boundary.

The geotechnical aspects of road design and construction which will be considered in this section are as follows:

- Cut Slopes
- Embankments
- Subgrade
- Structure Foundations
- Earthwork Material Acceptability
- Contaminated Land
- Soil Chemistry
- Karst
- Tunnelling

The earthworks areas of cut and fill are presented in Drawings **GCOB-600-D-201** to **212** in **Volume 2** and in tabular format in **Appendix A.5.2**.

This assessment is in addition to the design requirements and construction methodologies presented in the Construction Environmental Management Plan (CEMP).

5.6.1 Cuttings

A total of 14 earthworks areas along the mainline are classified as cuttings along with a proportion of the N59 Link Road. The soil sequence exposed in the cuttings will be a variable sequence of glacial soils underlain by bedrock in some places.

A preliminary assessment of the cutting stability was undertaken based on the guidelines set out in the Transport Research Laboratory (TRL) report LR199. Based on the assessment it is recommended that all batters are constructed at a maximum gradient of 1 vertical to 2 horizontal (1V:2H), and that this be the criterion for land acquisition.

This is in line with Clause 603.1 of the TII SRW Series 600 Earthworks, which states that the final face of all cuttings (other than cuttings through rock) shall have a maximum gradient of 1V:2H.

The current proposal is to construct the batters with a uniform gradient over the full height of the cutting slope, in order to maintain a uniform visual appearance to the batters. However, there is scope to steepen the batter slopes where bedrock is exposed in the lower sections of the cut. Permanent rock cut slopes of 1V:1.5H are achievable.

In accordance with the TII road construction detail CC-SCD-00607, a minimum bench of 2.0m width is required at the interface of overburden soil and competent rock. An intermediate rock bench of 3.0m width is required where the rock cutting slopes are greater than 12.0m.

Excavated topsoil, overburden and bedrock from cuttings will be separated and temporarily stored in stockpiles within the proposed development boundary. These stockpiles shall be processed and reused within the construction of the proposed road development. A summary of the proposed batter slope gradients, together with typical soil profiles for each cutting are presented in **Appendix A.5.2**.

5.6.1.1 Cut Slopes in Peat / Soft Ground

Peat and / or soft deposits are anticipated to be encountered in cutting areas. An assessment has been conducted of the likely extent of the peat deposits and associated volume of material. The areas are outlined in **Section 5.5.2**.

In areas where peat is identified and a sufficient land take is available, the material will be excavated and replaced with suitable material on the slope face. Alternatively retaining measures shall be implemented. The possible retaining measures include very shallow slopes, gabion baskets or similar retaining systems.

5.6.1.2 Cut Slopes in Glacial Deposits

The Glacial Deposits exposed in the cuttings will predominantly comprise of Sand and Gravel in Section 1 and Silt / Clay from Section 2 to 4.

Based on the preliminary assessment soil slopes in the Glacial Deposits with a gradient of 1V:2H and maximum slope height of 5.0m will generally be considered stable.

Slopes with a gradient of 1V:2H and with a height greater than 5.0m may be at an increased risk of failure. Where soil slopes are deemed to have a risk of failure, shallower slopes, surface drainage or retaining measures will be implemented. The location of these are outlined in **Appendix A.5.2**.

5.6.1.3 Cut Slopes in Rock

The bedrock will consist of either Granite or Limestone. The weathering profile of the rockhead is variable, particularly within the Limestone and the weathered zone was found to range from less than 0.5m up to 2.7m in thickness.

Based on the preliminary assessment of slopes in competent rock a gradient of 1V:1.5H will be considered stable, slopes in weathered rock will also be considered stable at 1V:1.5H, a minimum 2.0m bench will be required at the interface between weathered and competent bedrock as per TII road construction detail CC-SCD-00607.

A preliminary assessment of the rippability / excavatibility of the bedrock indicates that the majority of the rock will require blasting to loosen, particularly for the Granite. Rippability and blasting will be designed by specialist contractors based on each cuttings pre-identified receptor limitations.

5.6.1.4 Existing Cut Slopes in Rock

Rock slope stability from existing rock slopes will be achieved by the following methods:

1. Construction of an embankment in front of the existing rock slope, refer to **Section 5.6.2.4** of this report.
2. Breaking back the existing rock slopes by ripping or blasting the rock to a designed rock slope gradient in accordance with best practice guidance documents, Transport Research Laboratory reports for rock slopes.
3. Installation of a permanent composite rock support system, designed to the relevant design standards (Eurocode 7, BS8081) and best practice guidance documents.

A permanent composite rock support system will include one or a combination of the following support solutions:

i. Rock bolts

ii. Rock dowels

iii. Steel mesh

iv. Sprayed concrete

Rock Bolts

There are several types of rock bolts, which generally consist of plain steel rods with a mechanical or chemical anchor at one end and a face plate and nut at the other. During the installation the rock bolt anchor (steel rod) will be inserted into a borehole that has been drilled through the rock face. The anchor is tensioned after installation and grouted. They work by 'knitting' the rock mass together sufficiently prohibiting movement to loosen and fail the rock slope. Rock bolts are effective as they are anchored into the stronger rock mass, i.e. beyond the blast affected zone. Rock bolts are generally installed in patterns. The exact length, spacing and tension strength depend on the rock mass characteristics, bolt structural capacity, design standard requirements and best practice guidance documents. The rock bolts may extend in length up to 10m.

Rock Dowels

Rock dowels generally comprise deformed steel bars which are grouted into the rock. Unlike rock bolts, tensioning is not possible and the load in the dowels is generated by movements in the rock mass. In order to be effective, dowels have to be installed before significant movement in the rock mass has taken place.

Like rock bolts, rock dowels are inserted into a borehole drilled into the quarry face, however they are inserted after grouting of the hole, and will be up to 3m in length. The exact length and positioning of the rock dowels depend on the rock bolt design, rock mass characteristics, dowel structural capacity, design standard requirements and best practice.

Steel Mesh

Following the installation of the rock bolts and dowels, an added safety measure is the installation of a steel mesh. The steel mesh will be held in place by the rock bolts. This will act as a cover on the rock face, protecting against the movement of any failures.

Sprayed concrete

An additional safety measure is using a sprayed concrete, shotcrete, coating which covers the rock bolts, dowels and steel mesh to further stabilise the rock face. Shotcrete is usually used in conjunction with a steel reinforcement, and in this instance the steel mesh will provide sufficient support. Shotcrete is sprayed onto the rock face surface pneumatically via a shotcrete machine. Where shotcrete is utilised weep holes will be installed to allow the groundwater drain.

5.6.1.5 Drainage

All drainage measures required are discussed in **Chapter 8, Drainage, Hydrology & Flood Risk**.

5.6.1.6 Swelling and Uplift Potential

There is potential for swelling (heave) to occur along the proposed road development. The occurrence of swelling or heave is likely to occur in the following situations:

- Where the base of a cutting is within cohesive overburden
- Where the base of a cutting is below design ground water level

- Where the effective stress changes during the unloading process

A preliminary assessment of the proposed road development cuttings indicates that there is potential for swelling to occur along the Western Approach to Lackagh Tunnel, at the Headford Road Junction, at the N83 Tuam Road Junction and Galway Racecourse cuttings.

The swelling / heave may be mitigated in the above scenarios by:

- Reducing the rate of excavation which permit the effective stress to adapt and natural heave to occur
- Installation of a thicker, denser road build-up and base to reduce the difference in original and design effective stress
- Installation of tension piles under the proposed road footprint to anchor the road

There is potential for uplift to occur along the proposed road development where the groundwater table is above the road level and sealed to prevent from ingressing the cutting. This occurs along the Western Approach to Lackagh Tunnel and the approaches to Galway Racecourse Tunnel.

Potential for uplift may be mitigated by:

- Having sufficient selfweight of the road build-up and base to prevent uplift which may require excavation and installation of a thicker, denser material
- Installation of tension piles under the sealed road to anchor and prevent uplift

5.6.2 Embankments

A total of 17 earthworks areas along the mainline are classified as embankments along with a proportion of the N59 Link Road. The subsoil profile beneath the embankments will comprise predominantly of till overlying bedrock. Peat is anticipated along the footprint of some of the embankments.

A summary of the proposed embankment layout and design together with a summary of the ground and groundwater conditions is provided in **Appendix A.5.2**.

A preliminary assessment of embankment stability has been carried out based on the guidelines set out in TRL LR199. Based on the assessment it is proposed that all embankments be constructed with slopes of 1V:2H.

This is in line with Clause 608.1 of the TII SRW Series 600 Earthworks, which states that all fills, including embankments, shall be constructed with a maximum gradient of 1V:2H.

Based on the preliminary assessment soil embankment slopes with a gradient of 1V:2H and maximum slope height of 5.0m will generally be considered stable.

In general embankment slopes can be subject to shallow surficial erosion and slips, particularly during periods of intense rainfall.

Soil embankment slopes with a gradient of 1V:2H and with a height greater than 5.0m may be at an increased risk of failure.

For soil embankments greater than 5.0m, drainage layers consisting of granular material may be incorporated at selected intervals within the embankment to encourage seepage downward and thus increasing slope stability.

5.6.2.1 Embankment Foundation Treatment

Due to the anticipated relatively limited length and depth of the Peat along the route, it is recommended that this material is excavated and replaced with suitable compacted coarse granular fill in compliance with Table 6/1 of the TII SRW series 600 Earthworks.

In areas where soft Alluvium underlies the embankments there are a number of options which could be adopted to improve foundation conditions for these embankments. The options available are as follows:

- Excavate and replace poor material with granular fill
- Shear keys: excavate first metre of poor material beneath embankment and beyond footprint (to 1.0m either side), line with geotextile, backfill with suitable granular material to ground level, construct embankment
- Provide soil reinforcement to the lower sections of the embankment
- Staged construction of embankments with surcharging to allow dissipation of pore water pressures between stages and consolidation of underlying soils
- Increasing consolidation and pore water pressure dissipation by inserting vertical band drains beneath the embankment
- Soil stabilisation or ground improvement
- Berms, widening of embankment base or shallower slopes can be implemented in areas where slope stability is a cause for concern

The options above could be used individually or in combination.

Karst potential beneath the embankment footprint is further discussed in **Section 5.6.8**.

A summary of the ground and groundwater conditions for the proposed road development are presented in **Appendix A.5.2**.

5.6.2.2 Embankments in Floodplains

Available flood extent mapping was assessed for the proposed road development. Locations identified where embankments are located in floodplains have been described in **Appendix A.5.2**. A detailed flood risk assessment has been carried out for the scheme and is presented in **Appendix A.8.6**.

A drainage layer or starter layer, in accordance with the TII road construction detail CC-SCD-00606, shall be implemented for the construction of embankments in floodplains. In accordance with construction detail, the starter layer is to be constructed to 0.5m above the maximum flood level across the full width of the embankment. The introduction of a drainage layer will ensure hydraulic conductivity exists across the flood plain.

5.6.2.3 Embankments in Granite Bedrock Areas

The overburden across the proposed road development consists of glacial till derived from the underlying bedrock. The bedrock changes between Sections 1 and 2, EW 13, 14, 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.

To prevent impact to the local environment the following fill limitations will be incorporated at the locations identified inTable 5.13: Fill Limitation Areas**Table 5.13**.

- 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 5.13: Fill Limitation Areas

Location	**Fill Limitation Chainage area**	
	From	**To**
1	0+620	0+775
2	1+300	1+450
3	1+830	2+065
4	2+875	3+090
5	3+440	3+550
6	3+595	3+890
7	4+800	5+150
8	7+850	7+900

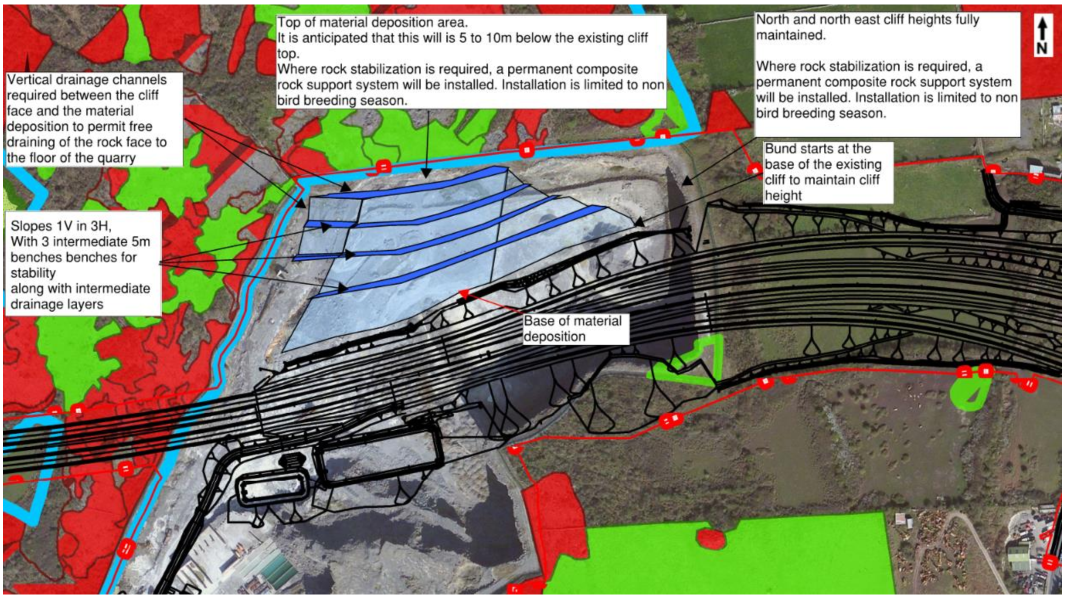
5.6.2.4 Embankments in Lackagh Quarry for Stability

Material deposition is required within Lackagh Quarry to provide stability to the existing blast damaged rock face and prevent encroachment on the Lough Corrib cSAC including Annex I habitat, refer to **Plate 5.01**. Particular requirements for this deposition area include:

- Granular layers (class 1 type material) will be introduced into the fill area to control slope stability, the contractor is required to complete a slope stability assessment of each area
- Free draining granular material required up to +17.7mOD
- Free draining granular material required between the existing cliff face and the material deposition material to allow the cliff face to maintain its drainage system

- A filter separator (e.g. geotextile) is required between the horizontal interface of free draining material and U1 material to prevent the migration of fines material
- Intermediate benches

Plate 5.01: Schematic of Lackagh Quarry Rock Face stability by Material Deposition



5.6.3 Subgrade

The proposed road development encounters several different soil types with different characteristics, as noted in **Section 5.4**. As such the subgrade will vary across the proposed road development, as it traverse between cut/fill areas and the transition zones between these areas.

The ground investigation data indicates that bedrock will likely be encountered in all of the principal cuttings. A transition will exist within the cutting from rock to soil and as such the pavement design will be required to accommodate the variation in subgrade stiffness at these transition zones.

The embankments will be constructed out of available material in accordance with the permitted constituents and material properties outlined in Table 6/1 of TII SRW Series 600 Earthworks.

A brief outline of the design assumptions and the recommended minimum CBR values is provided below.

5.6.3.1 Glacial Gravel (derived from Granite)

Using a best fit line through available CBR data and the average NMC value of 15%, the CBR equals approximately 7%. This is provided in **Appendix A.5.4**, **Figure 5.34**. However, as indicated in **Section 5.5.4.2**, the maximum NMC encountered was 54%.

The NMC values as plotted in **Appendix A.5.4**, **Figure 5.04**, indicate that the moisture content decreases with depth. It is likely in shallow cuts, transition zones and at the subgrade of certain embankments that the anticipated CBR will be lower than 7%.

An estimated minimum expected CBR value for the glacial gravel is 2.5%, which generally equates to a thin layered construction in cohesionless material.

5.6.3.2 Glacial Till (derived from Granite)

Using a best fit line through available CBR data and the average NMC value of 29%, a CBR value was not achievable. This is provided in **Appendix A.5.4**, **Figure 5.35**. As indicated in **Section 5.5.5.2**, the material has a high to extremely highly plasticity and is likely unacceptable for reuse as general fill material.

Such material is likely to be thin and isolated and will likely be removed and replaced with more suitable material where required. An estimated minimum expected CBR value for such material is 1%, based on silt description as per IA 73/06 (2009).

5.6.3.3 Glacial Gravel (derived from Limestone)

In accordance with Table 5.1 of IA 73/06 (2009), an estimated minimum expected CBR value of 3% is recommended for the glacial gravel.

5.6.3.4 Glacial Till (derived from Limestone)

Using a best fit line through available CBR data and the average NMC value of 11%, the CBR equals approximately 5%. This is provided in **Appendix A.5.4**, **Figure 5.36**. However, as indicated in **Section 5.5.4.2**, the maximum NMC encountered was 47%.

The NMC values as plotted in **Appendix A.5.4**, **Figure 5.16**, indicate that the moisture content decreases with depth. It is likely in shallow cuts, transition zones and at the subgrade of certain embankments that the anticipated CBR will be lower than 5%.

In accordance with Table 5.1 of IA 73/06 (2009), an estimated minimum expected CBR value of 3% is recommended for the sandy clay with a PI of 10%.

5.6.3.5 Summary

The recommended minimum expected CBR values to be achieved on the proposed road development are summarised below in **Table 5.14**.

Table 5.14: Recommended Minimum Expected CBR Values

Material Classification	Minimum Expected CBR
Glacial Gravel (derived from Granite)	2.5%
Glacial Till (derived from Granite)	1.0%
Glacial Gravel (derived from Limestone)	3.0%
Glacial Till (derived from Limestone)	3.0%

5.6.4 Structure Foundations

Refer to the relevant Structure Preliminary Design Report in **Appendix A.7.1** for further details on foundation types and associated geotechnical aspects in relation to structures.

- GCOB-4.04-20-002 Standard Overbridges
- GCOB-4.04-20-003 Standard Underbridges
- GCOB-4.04-20-009 Galway Racecourse Tunnel
- GCOB-4.04-20-010 Menlough Viaduct
- GCOB-4.04-20-011 Lackagh Tunnel
- GCOB-4.04-20-012 River Corrib Crossing
- GCOB-4.04-20-013 Culverts and Underpasses
- GCOB-4.04-20-014 Other Structures

Chapter 7, Structures provides summary information for the structures that are part of proposed road development.

5.6.5 Earthworks Acceptability and Quantities

5.6.5.1 Topsoil

An assessment was conducted of the typical topsoil thickness based on available ground investigation data. It was determined that a topsoil thickness of 300mm was an average value across the proposed road development. Therefore, the volumes developed are based on a topsoil strip of 0.1m where rock was encountered in the west and 0.3m for the majority of other areas.

In accordance with Cl. 602.10 of TII SRW Series 600 Earthworks, topsoil which is covered by fill of greater than 3m in height can be left in place. However, in order to conduct karst inspections and proof rolling of subgrade in limestone areas, topsoil will likely be stripped for the entirety of the proposed road development to the east of the River Corrib.

5.6.5.2 Overburden / Subsoils

An earthwork acceptability assessment was conducted for each earthworks section. This was completed based on an assessment of the aerial photography and site walkover data for each earthworks area and location of the cutting, the depth of the cutting, the ground conditions and the material acceptability criteria as outlined in **Section 5.5** where relevant, and the volume of excavated material.

The Glacial Deposits are generally assumed to be highly moisture sensitive. Therefore, with proper handling, drying and processing, some of the U1 unacceptable may meet the material properties set out in Table 6/1 of the TII SRW Series 600 Earthworks. If the U1 unacceptable material is not appropriate for general fill through proper handling, drying and processing, it may be suitable for use as Class 4 landscape fill.

Section 1: Chainage 0+000 to 8+850

The acceptability assessment yielded an overall percentage of greater than 75% of site won material (excluding Topsoil) which would be acceptable for reuse. Greater than 90% of the reusable material was deemed to be granular.

It is anticipated that at least 20% of the material to be excavated will be deemed to be U1 unacceptable as it is not likely to comply with the assumed permitted constituents and material properties of Table 6/1 of the TII SRW Series 600 Earthworks or it consists of Peat or non-hazardous Made Ground.

Groundwater will be impacted if limestone derived material is placed on peat land areas, which forms part of much of the western section of the proposed route. A construction earthworks programme will be implemented for the proposed road development which categorises the source of material for each fill. Only granite derived material is permitted to be used in granite bedrock areas.

Section 2 - 4: Chainage 8+850 to 17+450

An assessment for the east of the river yielded an overall percentage of greater than 75% of site won material (excluding Topsoil) which would be acceptable for reuse. Greater than 80% of the reusable material was deemed to be cohesive.

It is anticipated that at least 20% of the material to be excavated will be deemed to be U1 unacceptable as it is not likely to comply with the assumed permitted constituents and material properties of Table 6/1 of the TII SRW Series 600 Earthworks or it consists of high plasticity or non-hazardous made ground.

5.6.5.3 Rock

In a number of cuttings the lower sections of the cutting comprises of Granite and Limestone bedrock. The rock will require crushing and processing before it can be used as an earthworks material. Central areas for crushing shall be identified at locations of the large rock cuttings. Further laboratory testing (i.e. NMC, OMC on crushed rock, LA abrasion, slake durability, aggregate crushing value, soundness, chemical testing) is required in order to determine suitability of the rock for uses such as:

- Drainage / starter layer comprising of selected granular fill Class 6B / 6C
- Capping for pavement foundations Class 6F2 / 6F1
- Pavement material Clause 804

- Fill to structures Class 6N1 / 6N2
- Other selected granular fill material Class 1

Section 1: Chainage 0+000 to 8+850

All of the Granite bedrock is assumed to be reusable as either Class 1 or Class 6 subject to suitable processing and testing in accordance with the material properties outlined in Table 6/1 of the TII SRW Series 600 Earthworks.

Therefore it was assumed that 100% of the Granite bedrock, where present in cuttings, is reusable.

Only granite derived material is permitted to be used in granite bedrock areas.

Section 2 - 4: Chainage 8+850 to 17+450

Fractures and voids within karstified Limestone can often contain crystalline calcite. The calcite is formed through precipitation in water-filled voids. Calcite is not suitable for reuse due to its highly variable nature and characteristics.

Limestone can also be interbedded with argillaceous rock such as shale, mudstones, slates that is rock compose of particles of Clay and Silt. These materials may not comply with the permitted constituents or properties for reusable material in accordance with Table 6/1 of the TII SRW Series 600 Earthworks.

Due to the factors highlighted above and the variable nature of undifferentiated limestone, only 95% was deemed to be reusable as either Class 1 or or Class 6 subject to suitable processing and testing in accordance with the material properties outlined in Table 6/1 of the TII SRW Series 600 Earthworks.

5.6.5.4 Mass Earthworks Volumes

The earthworks volumes have been separated based on underlying bedrock. The associated volumes are provided in **Table 5.15** and **Figure 5.6.1**.

Figure 5.6.1: Summary of Excavated Volume Surplus / Deficit

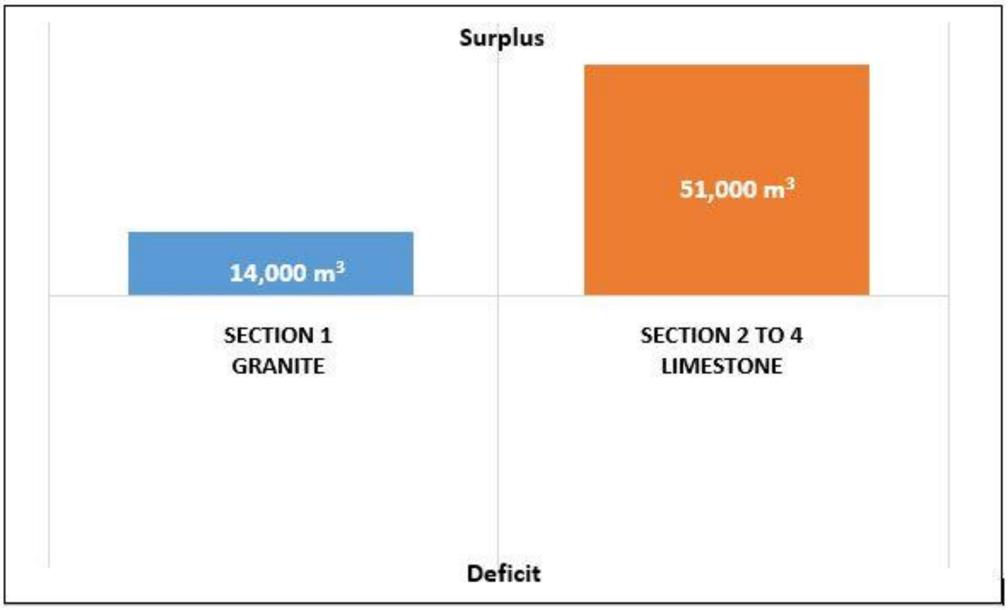


Table 5.15: Topsoil Volumes

Reference Area	Chainage		Estimated Quantities (million m^3)		
	From	To	Excavated	Fill	Surplus (+) / Deficit (-)
Section 1	0+000	8+850	0.065	0.043	+0.022
Section 2 to 4	8+850	17+550	0.087	0.075	+0.012

Table 5.16: Mass Earthworks Volumes

Reference Area	Chainage		Estimated Quantities (million m^3)			
	From	To	Class 1&2	U1 & U2	Fill	Surplus (+) / Deficit (-)
Section 1	0+000	8+850	0.840	0.106	0.827	+0.014
Section 2 to 4	8+850	17+550	1.931	0.169	1.880	+0.051

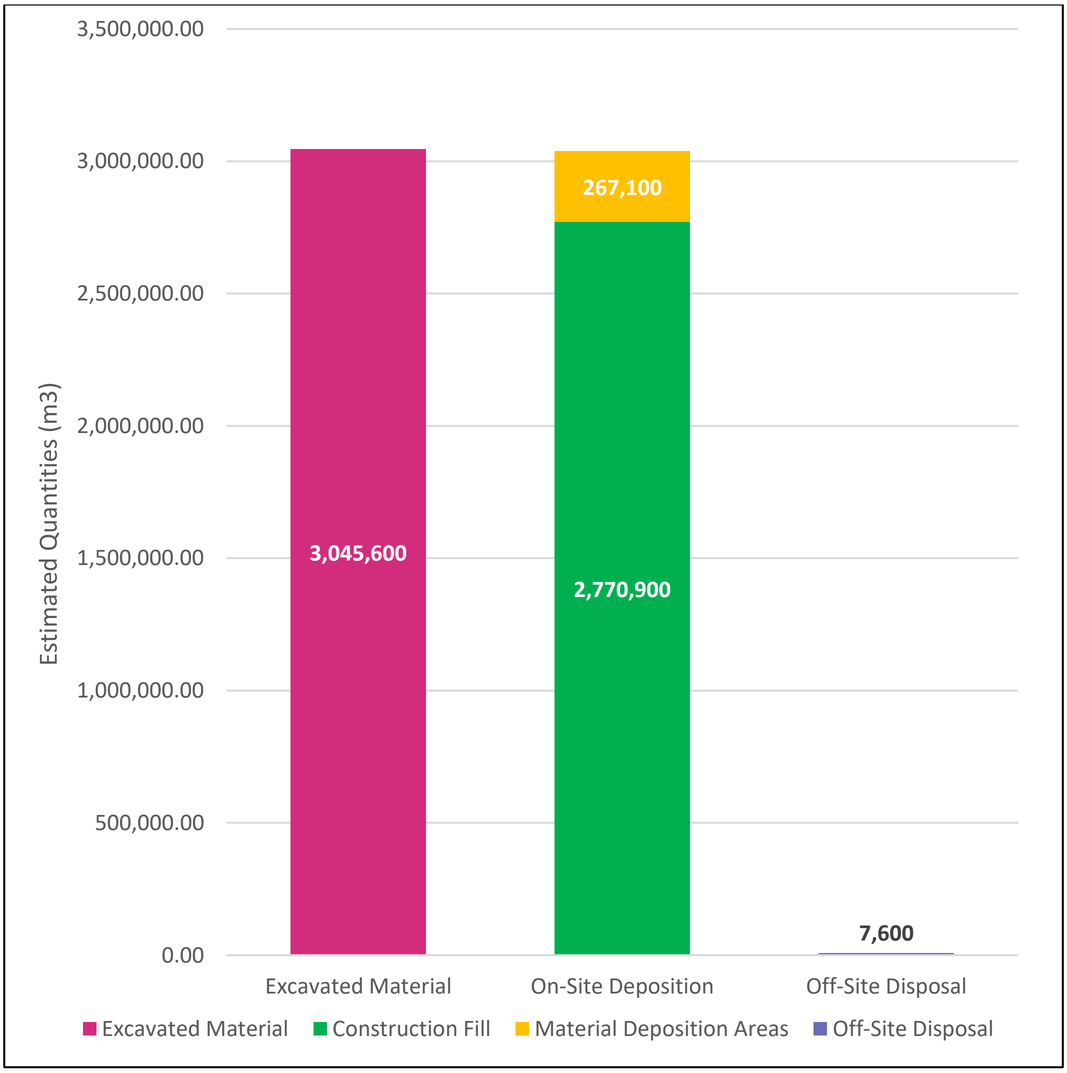
The volumes provided in **Table 5.16** are derived based on the following assumptions:

- Class 1 and Class 2 quantities consist of accep and marginal material
- Granite is assumed as 100% accep

- Limestone is assumed as 95% accep due to anticipated presence of calcite and argillaceous material in some rock cuttings
- Fill includes assumed capping and sub base requirements
- Material acceptability criteria as per **Section 5.5** has been applied for each earthworks area
- Topsoil strip assumed between 0.1-0.3m
- Removal of Peat and subsequent fill required based on max thickness and locations provided in **Table 5.4**
- Section 1 and 2 includes accep rock quantity as it is assumed that it will be reused as either Class 6 selected granular fill or Class 1 general fill after processing

The volumes as provided in **Table 5.15** and **Table 5.16** have been summarised and are provided below in **Figure 5.6.2**.

Figure 5.6.2: Summary of Material Excavation Activities



5.6.6 Contaminated Land

No areas of contaminated ground have been identified along the proposed road development through consultation with Galway County Council to determine the presence of legacy landfill sites along the proposed road development and during the ground investigation. It is possible that local / man-made dumping pits exists comprising of farm waste or construction and demolition waste. Areas of Made Ground or likely Made Ground have been identified in **Section 5.5.1.1**.

5.6.7 Soil Chemistry

An assessment of the aggressiveness of the ground to concrete was conducted in accordance with IS EN 206:2013. 2 indicates the limiting values for concrete exposure classes for chemical attack in terms of groundwater and soil. Areas which fall within a concrete exposure class are provided below in **Table 5.17**. If concrete is required in these areas an appropriate concrete mix is required. Samples of Peat have been ignored as the majority of Peat tested is indicated to be highly organic and acidic.

Table 5.17: Areas of Aggressive Ground

Earthworks Section	**Chainage**	**Exploratory Location**	**Depth**	**Max pH (groundwater)**	**Max SO_4^2 mg/kg (soil)**	**Exposure Class**	**Exposure Class Description**
Section 1 EW01	0+420	TP3/03	0.5	6.2	357	XA1	Slightly aggressive chemical environment
Section 1 EW02	0+750	TP322A[1]	0.5	5.4	1320	XA2	Moderately aggressive chemical environment
Section 1 EW02	1+200	TP3/07	0.2	5.3	127	XA2	Moderately aggressive chemical environment
Section 1 EW02	1+450	TP3/06	1.1	6.4	362	XA1	Slightly aggressive chemical environment
Section 1 EW03	2+870	TP3/14	0.2	4.7	15	XA2	Moderately aggressive chemical environment
Section 1 EW04	3+880	TP3/16	0.2	5.7	15	XA1	Slightly aggressive chemical environment
Section 1 EW06	4+700	TP3/17	0.5	5.2	174	XA2	Moderately aggressive chemical environment
Section 1 EW08	5+660	TP3/19	0.5	6.4	15	XA1	Slightly aggressive chemical environment
Section 1 EW08	6+740	TP3/21	0.2	6.4	15	XA1	Slightly aggressive chemical environment
Section 4 EW32	16+080	TP3/32	0.4	5.2	-	XA2	Moderately aggressive chemical environment

[1] These exploratory locations are not located directly on the proposed road development but have been included to display characteristics of the surrounding environment.

5.6.8 Karst

All known or potential karst anomalies are discussed in the Karst Study Report as provided in **Appendix A.5.3.1** and as discussed in Chapters 9 and 10 of the EIA Report. Karst risk is only applicable from Section 2 to Section 4.

The eastern section of the proposed road development is underlain by Limestone where there is some risk of karst subsidence (i.e. rock or superficial soils collapsing leaving a surface depression of voided, weak ground). Most of the karstification identified consists of a weak to well-developed zone of epikarst, ranging from approximately 0m to 2.7m in thickness[2] (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 unpredic nature of karst subsidence is recognised in the course of the design and construction works. Karst features represent a hazard to construction operations and may represent a hazard to the performance of the proposed road development. They also represent potential point inputs were runoff from the site could enter the aquifer impacting on groundwater and downstream surface water receptors.

A karst protocol is included in **Appendix A.5.3.2**. The protocol outlines the various remedial works which can be applied if features are encountered beneath earthworks, in cutting slopes and below structure foundations.

5.6.9 Tunnelling

There are two tunnels located along the proposed road development. Refer to **Appendix A.7.1** for the Preliminary Design Report for the relevant tunnel structures and the associated geotechnical aspects.

- GCOB-4.04-20-009 Galway Racecourse Tunnel
- GCOB-4.04-20-011 Lackagh Tunnel

The construction methodology and geotechnical characteristics of the approaches to these structures are discussed in the design reports referenced above.

[2] 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 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.

5.6.10 Other Geotechnical Items

Additional geotechnical aspects which require further evaluation are provided below:

- Blasting in areas of rock excavation

5.6.10.1 Blasting

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, refer to **Section 5.5.9.3** and **5.5.10.3** of this report.

A blasting assessment was conducted in both the Granite and Limestone bedrock to determine the feasibility of blasting adjacent to sensitive receptors along the proposed road development. This assessment was conducted by analysing the estimated blast-induced ground vibrations and determining the subsequent exclusion zones based on blasting activities. It can be summarised that blasting is feasible in both Limestone and Granite bedrock however exclusion zones may be required based on bench height and proximity to receptors. Refer to the blast feasibility and exclusion requirements note presented in **Appendix A.5.5.1**.

An assessment was conducted of the cuttings in bedrock to determine the potential blasting locations during construction, these locations are presented in **Appendix A.5.5.2**.

5.6.10.2 Menlough Viaduct

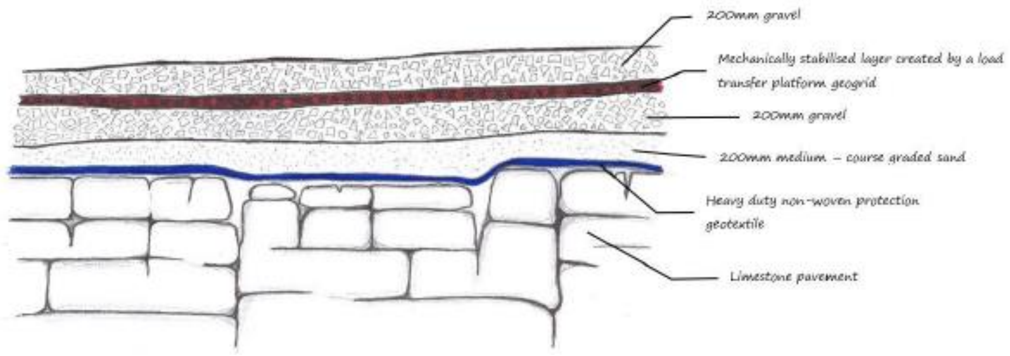
During construction of Menlough Viaduct, the Limestone pavement at Menlough Viaduct will be protected by implementing a protection system comprising of geogrid, protection geotextile and layers of material. This will be removed once construction is complete.

The protection system will incorporate layers of materials to firstly protect the surface of the Limestone pavement but also to redistribute the construction loadings and avoid point loads which may cause induced cracks to the surface of the Limestone pavement. **Plate 5.03** below shows an indicative sketch of this protection system which is made up of the following:

1. A heavy duty non-woven protection geotextile layer on the surface of the Limestone pavement
2. A layer of sand to form a level surface and protect the geotextile from tearing due to the gravels
3. A layer of gravels to provide stability and an interlocking system for the load transfer platform geogrid
4. A load transform platform geogrid to redistribute the point loadings and provide a mechanically stabilised layer and a safe working platform for construction

A layer of gravels to provide an interlocking system for the mechanically stabilised layer and clause 804 or similar surface for construction traffic to traverse.

Plate 5.03: Limestone pavement protection system



Refer to Menlough Viaduct Structure Preliminary Design Report, GCOB-4.04-20-010 Menlough Viaduct, in **Appendix A.7.1** for further details on foundation types and associated geotechnical aspects.

5.6.10.3 Galway Racecourse Tunnel

The Galway Racecourse Tunnel and its approaches are beneath the design ground water level.

Waterproofing of this section of the proposed road development will be achieved by the installation of an impermeable geomembrane. The geomembrane will be attached to the concrete tunnel structure using a watertight clamp seal and surface anchored.

To control uplift, caused by water pressure, in the eastern approach section, ballast will be placed on the geomembrane. The thickness of the ballast is governed by the ballast bulk density, the depth below design ground water level and designed to design standards. Uplift beneath the tunnel section is counteracted by the self-weight of the structure. Between the tunnel section and the eastern approach a transition zone will be implemented where the geomembrane is gradually buried with ballast. Refer to Drawing **GCOB-600-D-301**, in **Volume 1** for details.

Refer to Galway Racecourse Tunnel Structure Preliminary Design Report, GCOB-4.04-20-009 Galway Racecourse Tunnel, in **Appendix A.7.3** for further details on foundation types and associated geotechnical aspects.

5.6.10.4 Barn Owl Mitigation at Menlough

Between chainages Ch 9+600 and Ch 10+100 environmental mitigation for the local Barn Owl population is required. The embankment in this area ranges between 7m and 19m in height as it crosses above the undulating topography. A dense double tree line with trees of at least 3m high above the adjacent proposed carriageway is proposed to mitigate against the potential impacts on the surrounding Barn Owl population. This will be achieved by widening the verges locally to 6m where possible and planting a double row of trees in a topsoiled planting bed at the top of the embankment. The planting bed will be surrounded by a root barrier system to prevent ingress of roots systems into the embankment fill. The 1:2 embankment slope will also be planted with shrubs and hedging which in time will grow to a sufficient height to provide for effective mitigation of potential impacts on Barn Owl crossing. This will allow the larger trees to be removed once the surrounding vegetation is sufficiently mature (i.e. after approximately 5-7 years).

Refer to Drawing **GCOB-600-D-401**, in **Volume 2** for further details.

5.7 Risk Register

A geotechnical risk register has been prepared at Phase 3 for the proposed road development. The potential hydrogeology and geotechnical risks outlined in this document are summaried below:

- Contamination of productive aquifers in Limestone area
- Contamination of productive aquifers in Granite area (few aquifers and volume low)
- During construction groundwater level and rate of inflow differs from anticipated e.g. Cuts intercept groundwater - changes to drainage design and slope stability
- Unknown karst features are encountered during construction
- Changes to cut / fill balance in Granite area resulting in a change in the percentage reusability/acceptability
- Changes to cut / fill balance in Limestone area resulting in a change in the percentage reusability/acceptability
- Soil and rock slope stability, areas where an unsupported standard slopes are not feasible and design solutions are required e.g. gabions, retaining walls, rock bolts, anchors, mesh, etc. required
- Change to volume of rock requiring blasting
- ABP restrictions on blasting due to proximity to sensitive receptors
- Remediation to properties in areas adjacent to blasting
- Unknown contaminated land encountered
- Adverse weather conditions influencing acceptability of material
- Lackagh Tunnel: Differential settlement, uplift or heave at transition zone at western exit of the tunnel, design, construction and operation
- Lackagh Tunnel: Cut permeability (section 3) e.g. construction period limited when works are below the groundwater level

6 Pavement Design

6.1 General

The pavement design options for the N6 Galway City Ring Road have been completed in accordance with TII Publications PE-SMG-02002 (Addendum to UK DMRB HD24/06) and DN-PAV-03021.

The pavement is designed for a 40-year design life in accordance with recommendations outlined in TII Publications PE-SMG-02002.

A fully flexible pavement design has been completed for the pavement design options; however, as the Design is progressed through detailed design this may be changed to flexible composite design.

Approval for the preliminary pavement options contained in this document, and any additional pavement options shall be sought from the Roads Authority prior to construction. The final selection of the preferred pavement option (e.g. flexible composite or fully flexible) for each road feature will be made in the detailed design phase of the project prior to construction. Refer to Drawings **GCOB-100-D-300** to **305** in **Volume 2** for typical pavement cross-sections.

6.2 Pavement Design

6.2.1 Traffic Assessment

The pavement million standard axle (MSA) values for the project roads are detailed in **Table 6.1** below and **Figures 6.1** to **6.4** can be used as visual support to locate sections along the proposed road development. The predicted traffic from the Design Year 2039 High Growth Scenario Average Annual Daily Traffic (AADT) and percentage Heavy Goods Vehicles (HGV) values have been used in this assessment. Annual Average Daily Flow (AADF) one-way directional flow has been deduced from the above figures assuming 50:50 directional split. Refer to Chapter 6, Traffic Assessment and Route Cross-Section of the EIA Report for further details.

Table 6.1: Design Life MSA Values

Reference	Description	msa
GCTP-700-001	Mainline - North of R336 Junction - (Ch. 0+000 - 1+150)	16
GCTP-700-002	Mainline - Na Foraí Maola - Troscaigh - (Ch. 1+150 - 1+600)	16
GCTP-700-003	Mainline - Troscaigh - Cappagh Road Junction - (Ch. 1+600 - 4+450)	20
GCTP-700-004	Cappagh Road Junction - Ballymoneen Road Junction - (Ch. 4+450 - 5+650)	25
GCTP-700-005	Mainline - Ballymoneen - N59 Junction (Ch. 5+650 - 7+575)	35
GCTP-700-006	Mainline - N59 Junction - N84 Junction - (Ch. 7+575 - 12+150)	78
GCTP-700-007	Mainline - N84 Junction - N83 Tuam Road Junction (Ch. 12+150 - 14+000)	114

Reference	Description	msa
GCTP-700-008	Mainline - N83 Tuam Road Junction - Briarhill Junction (Ch. 14+000 - 16+200)	86
GCTP-700-009	Mainline - Briarhill Junction - N6 Coolagh (Ch. 16+200 - 16+400)	113
GCTP-700-010	Letteragh Link Road North (Ch. 0+000 - 0+950)	22
GCTP-700-011	Letteragh Link Road South (Ch. 1+150 - 1+450)	22
GCTP-700-012	Letteragh Link Road South (Ch. 1+450 - 2+200 - Letteragh Road - Rahoon Road)	11
GCTP-700-013	Parkmore Link Road (Ch. 0+000 - 1+200)	2
GCTP-700-014	City North Business Park Link Road	1
GCTP-700-015	R336 Baile Nua East	16
GCTP-700-016	R336 Baile Nua West	16
GCTP-700-017	Na Foraí Maola to Troscaigh Link - North	1
GCTP-700-018	Na Foraí Maola to Troscaigh Overbridge Link	1
GCTP-700-019	Na Foraí Maola to Troscaigh Link - South	1
GCTP-700-020	L1321 Bearna Moycullen Road North	1
GCTP-700-021	L1321 Bearna Moycullen Road South	2
GCTP-700-022	L5384 Aille Road	1
GCTP-700-023	An Chloch Scoilte / Aille Local Road	1
GCTP-700-024	Cappagh Road North	1
GCTP-700-025	Cappagh Road South	6
GCTP-700-026	Ballymoneen Road North	4
GCTP-700-027	Ballymoneen Road South	7
GCTP-700-028	Rahoon Road – Clybaun Road Junction	1
GCTP-700-029	Clybaun Road Upper	1
GCTP-700-030	Rahoon Road West - Gort na Bró Junction	3
GCTP-700-031	Rahoon Road East - Gort na Bró Junction	11
GCTP-700-032	Letteragh Road West	1
GCTP-700-033	Letteragh Road East	11
GCTP-700-034	School Road	1
GCTP-700-035	N59 Moycullen Road	22
GCTP-700-036	N84 Headford Road	45
GCTP-700-037	N83 Tuam Road	58
GCTP-700-038	City East Business Park Road	3
GCTP-700-039	N6 Bóthar na dTreabh - City East Business Park Junction	37
GCTP-700-040	N6 Bóthar na dTreabh - Briarhill Link	59
GCTP-700-041	N59 Letteragh Junction EB Diverge Slip Road	1
GCTP-700-042	N59 Letteragh Junction EB Merge Slip Road	48
GCTP-700-043	N59 Letteragh Junction WB Diverge Slip Road	40
GCTP-700-044	N59 Letteragh Junction WB Merge Slip Road	1

Reference	Description	msa
GCTP-700-045	N84 Headford Road EB Diverge Slip Road	9
GCTP-700-046	N84 Headford Road EB Merge Slip Road	33
GCTP-700-047	N84 Headford Road WB Diverge Slip Road	55
GCTP-700-048	N84 Headford Road WB Merge Slip Road	9
GCTP-700-049	N83 Tuam Road EB Diverge Slip Road	13
GCTP-700-050	N83 Tuam Road WB Merge Slip Road	57
GCTP-700-051	Parkmore Link Road WB Diverge Slip Road	2
GCTP-700-052	Parkmore Link Road EB Merge Slip Road	1
GCTP-700-053	Coolagh EB Merge Slip Road	61
GCTP-700-054	Coolagh EB Diverge Slip Road	42
GCTP-700-055	Coolagh WB Merge Slip Road	19
GCTP-700-056	Coolagh WB Diverge Slip Road	52
GCTP-700-057	Monivea Road R339 East	4
GCTP-700-058	Ballybrit Crescent Road	18
GCTP-700-059	Briarhill Business Park Overlay	3

Figure 6.1: Visual aid showing locations of the pavement design criteria throughout the scheme – section 1/4

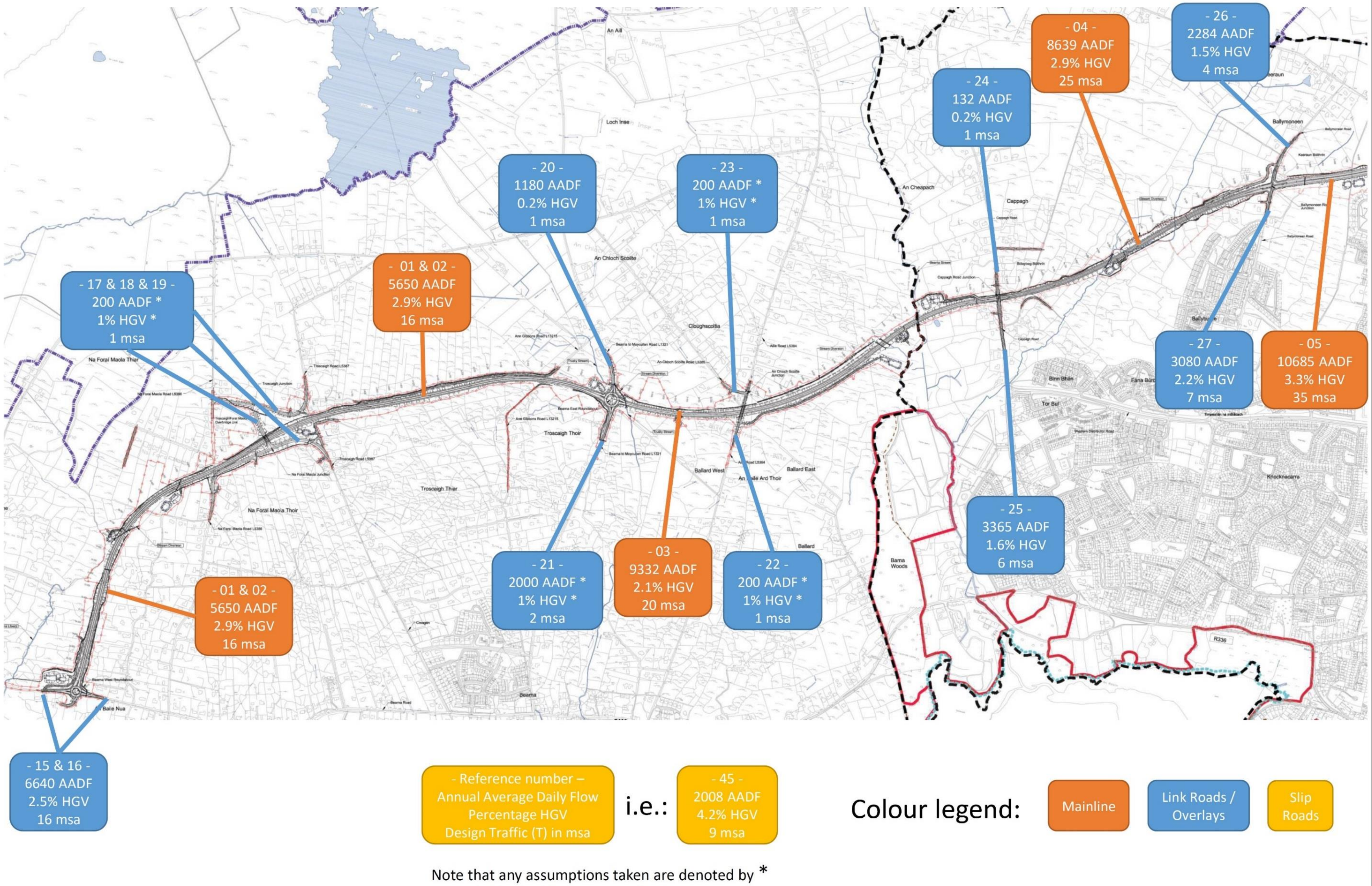


Figure 6.2: Visual aid showing locations of the pavement design criteria throughout the scheme – section 2/4

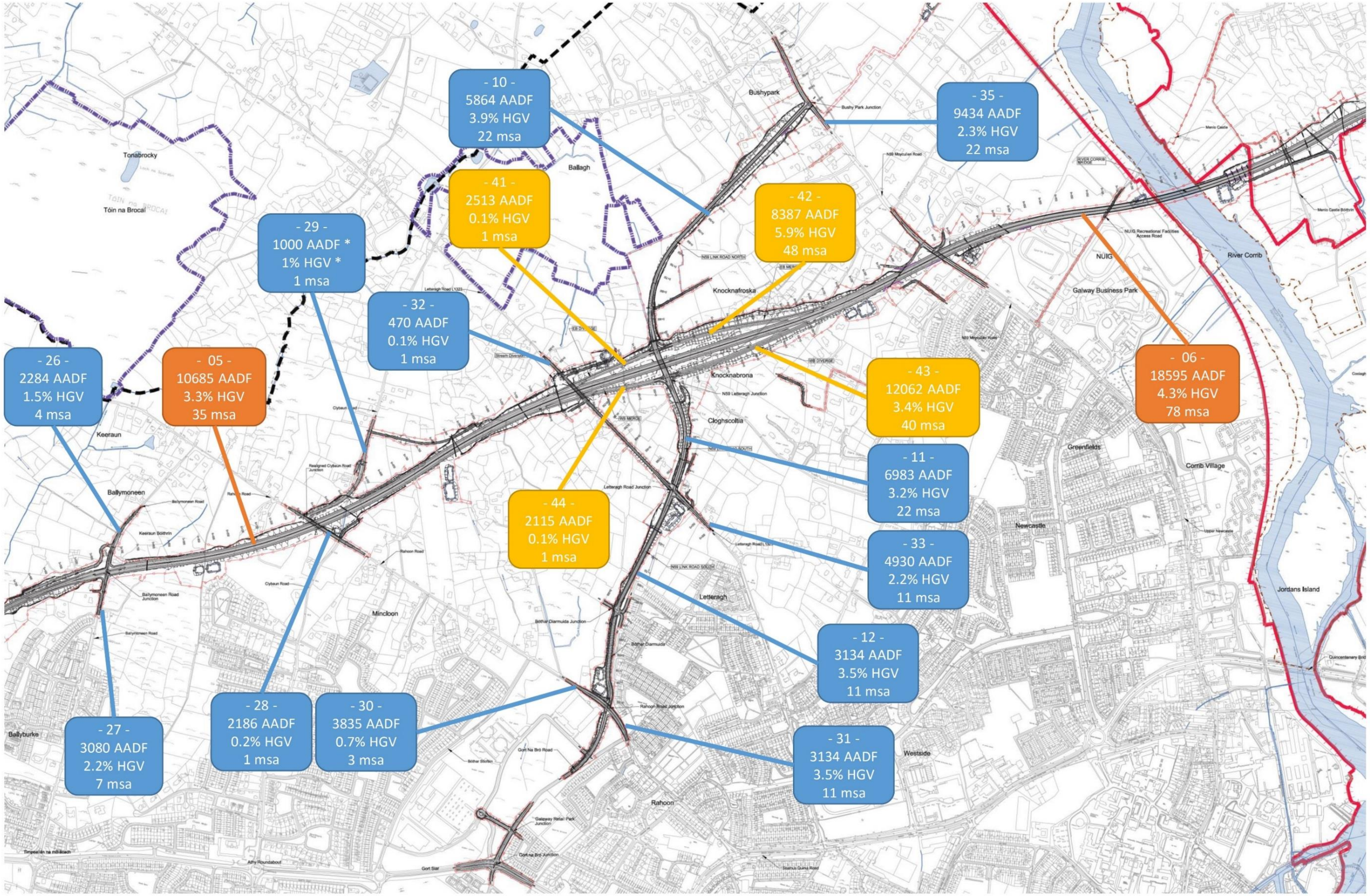


Figure 6.3: Visual aid showing locations of the pavement design criteria throughout the scheme – section 3/4

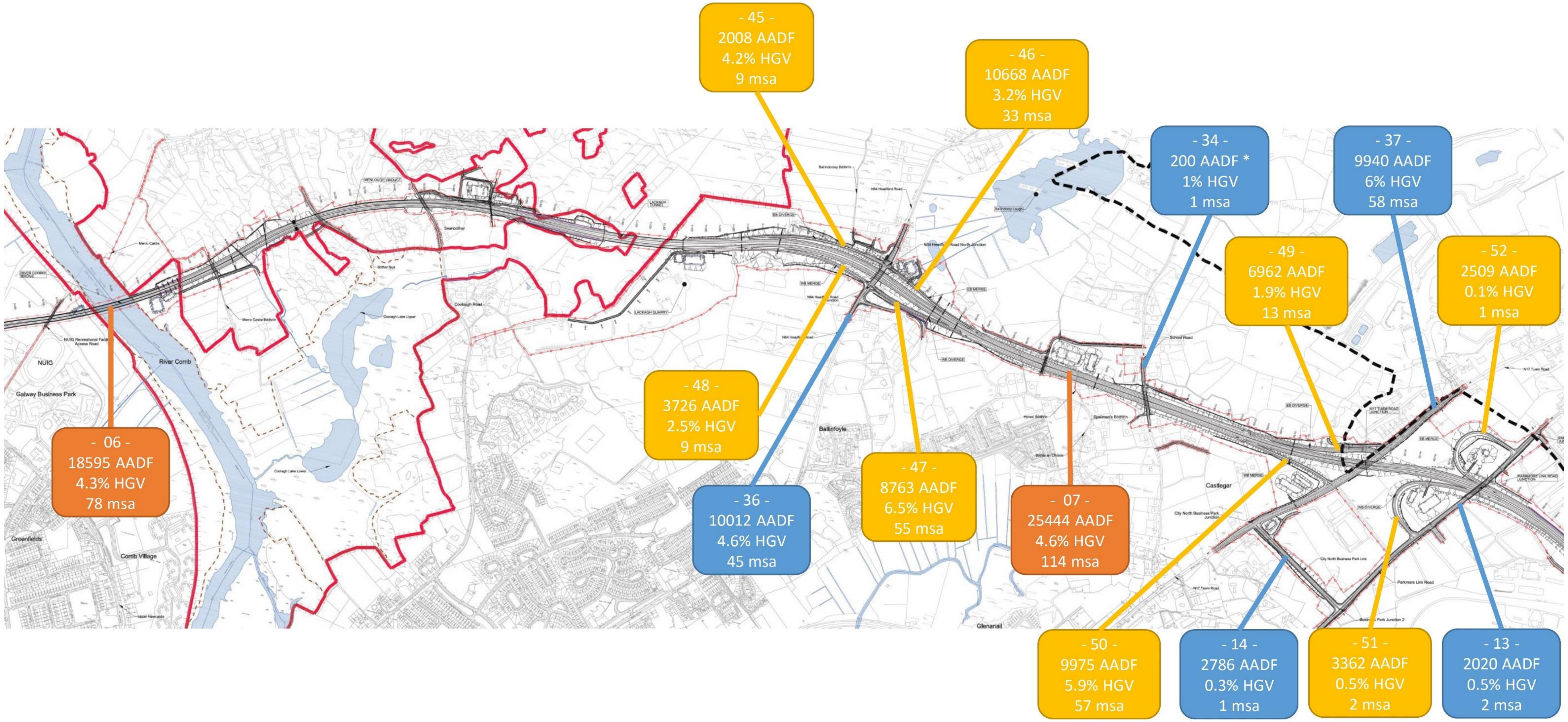
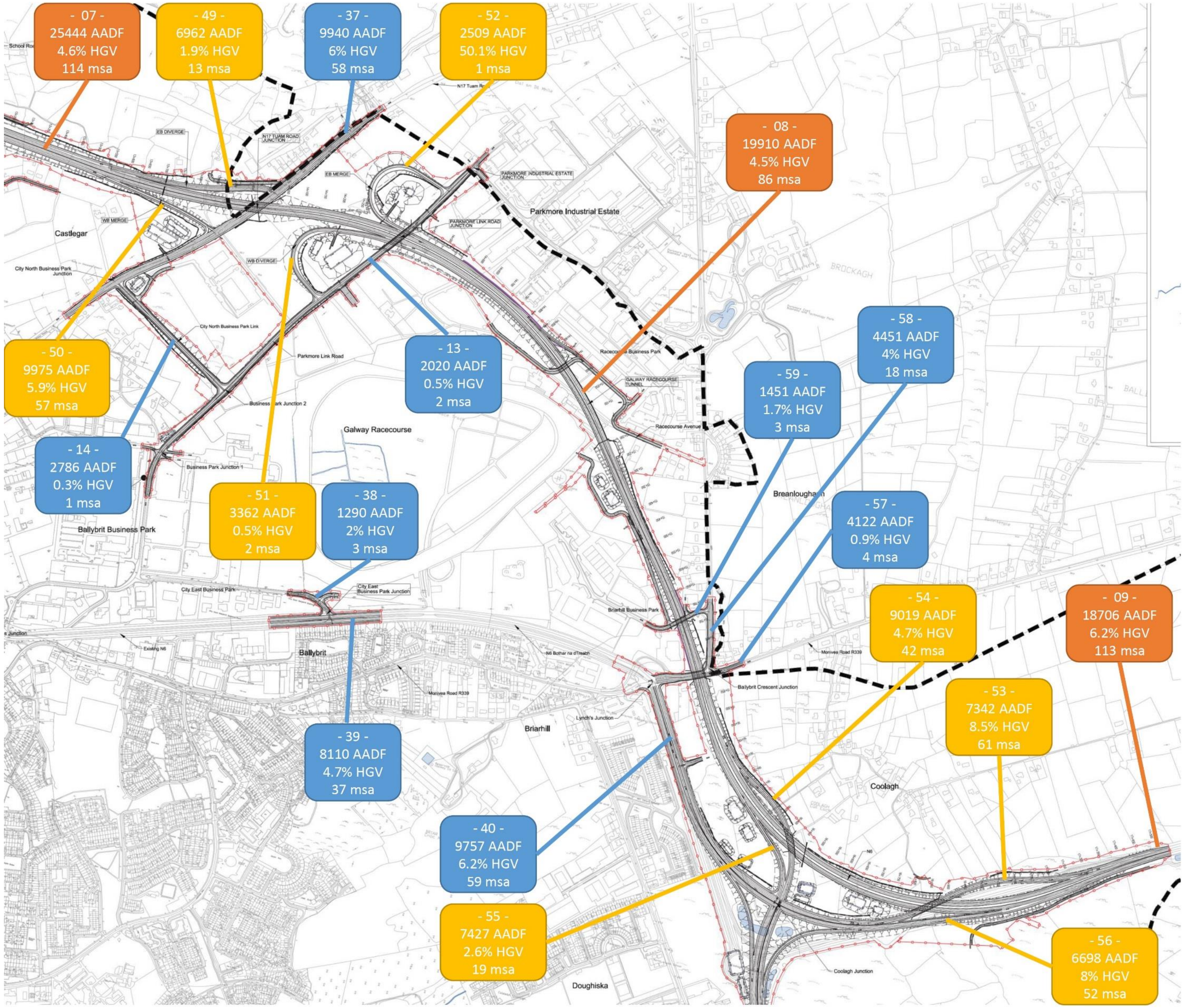


Figure 6.4: Visual aid showing locations of the pavement design criteria throughout the scheme – section 4/4



6.2.2 Pavement Thickness

Full depth pavement and capping thickness values, for a fully flexible pavement design, have been derived in accordance with DN-PAV-03021 Figure 4.1 and Figure 4.2. Capping thicknesses have been derived using estimated CBR values from geotechnical assessments of ground conditions. A surface course thickness of 40mm and binder course thickness of 50mm is provided across the proposed road development. A subbase thickness of 150mm is also provided across the proposed road development. Pavement thickness at bridge viaduct and tunnel structures will be a minimum of 125mm over the concrete deck slab or tunnel base. **Table 6.2** below details the pavement and capping thickness requirements. Note that some sections where widening, overlay or realignment is proposed, a full subbase or capping build up may not be required due to existing ground conditions.

Table 6.2: Pavement Thickness Calculations

Section	Description	Surface Course	Binder Course	Base	Sub base	Capping
GCTP-700-001	Mainline - North of R336 Junction - (Ch. 0+000 - 1+150)	40	50	180	150	400
GCTP-700-002	Mainline - Na Foraí Maola - Troscaigh - (Ch. 1+150 - 1+600)	40	50	180	150	400
GCTP-700-003	Mainline - Troscaigh - Cappagh Road Junction - (Ch. 1+600 - 4+450)	40	50	190	150	400
GCTP-700-004	Cappagh Road Junction - Ballymoneen Road Junction - (Ch. 4+450 - 5+650)	40	50	200	150	400
GCTP-700-005	Mainline - Ballymoneen - N59 Junction (Ch. 5+650 - 7+575)	40	50	210	150	400
GCTP-700-006	Mainline - N59 Junction - N84 Junction - (Ch. 7+575 - 12+150)	40	50	260	150	350
GCTP-700-007	Mainline - N84 Junction - N83 Tuam Road Junction (Ch. 12+150 - 14+000)	40	50	260	150	350
GCTP-700-008	Mainline - N83 Tuam Road Junction - Briarhill Junction (Ch. 14+000 - 16+200)	40	50	260	150	350
GCTP-700-009	Mainline - Briarhill Junction - N6 Coolagh (Ch. 16+200 - 16+400)	40	50	260	150	350
GCTP-700-010	Letteragh Link Road North (Ch. 0+000 - 0+950)	40	50	190	150	400
GCTP-700-011	Letteragh Link Road South (Ch. 1+150 - 1+450)	40	50	190	150	400
GCTP-700-012	Letteragh Link Road South (Ch. 1+450 - 2+200 - Letteragh Road - Rahoon Road)	40	50	180	150	400
GCTP-700-013	Parkmore Link Road (Ch. 0+000 - 1+200)	40	50	110	150	400

Section	Description	Surface Course	Binder Course	Base	Sub base	Capping
GCTP-700-014	City North Business Park Link Road	40	50	110	150	350
GCTP-700-015	R336 Baile Nua East	40	50	180	150	400
GCTP-700-016	R336 Baile Nua West	40	50	180	150	400
GCTP-700-017	Na Foraí Maola to Troscaigh Link - North	40	50	180	150	400
GCTP-700-018	Na Foraí Maola to Troscaigh Overbridge Link	40	50	180	150	400
GCTP-700-019	Na Foraí Maola to Troscaigh Link - South	40	50	190	150	400
GCTP-700-020	L1321 Bearna Moycullen Road North	40	50	110	150	400
GCTP-700-021	L1321 Bearna Moycullen Road South	40	50	110	150	400
GCTP-700-022	L5384 Aille Road	40	50	110	150	400
GCTP-700-023	An Chloch Scoilte / Aille Local Road	40	50	110	150	400
GCTP-700-024	Cappagh Road North	40	50	110	150	400
GCTP-700-025	Cappagh Road South	40	50	140	150	400
GCTP-700-026	Ballymoneen Road North	40	50	130	150	400
GCTP-700-027	Ballymoneen Road South	40	50	150	150	400
GCTP-700-028	Rahoon Road – Clybaun Road Junction	40	50	110	150	400
GCTP-700-029	Clybaun Road Upper	40	50	110	150	400
GCTP-700-030	Rahoon Road West - Gort na Bró Junction	40	50	120	150	400
GCTP-700-031	Rahoon Road East - Gort na Bró Junction	40	50	160	150	400
GCTP-700-032	Letteragh Road West	40	50	110	150	400
GCTP-700-033	Letteragh Road East	40	50	160	150	350
GCTP-700-034	School Road	40	50	110	150	400
GCTP-700-035	N59 Moycullen Road	40	50	190	150	350
GCTP-700-036	N84 Headford Road	40	50	230	150	350

Section	Description	Surface Course	Binder Course	Base	Sub base	Capping
GCTP-700-037	N83 Tuam Road	40	50	250	150	350
GCTP-700-038	City East Business Park Road	40	50	120	150	350
GCTP-700-039	N6 Bóthar na dTreabh - City East Business Park Junction	40	50	220	150	350
GCTP-700-040	N6 Bóthar na dTreabh - Briarhill Link	40	50	250	150	400
GCTP-700-041	N59 Letteragh Junction EB Diverge Slip Road	40	50	110	150	400
GCTP-700-042	N59 Letteragh Junction EB Merge Slip Road	40	50	230	150	400
GCTP-700-043	N59 Letteragh Junction WB Diverge Slip Road	40	50	220	150	400
GCTP-700-044	N59 Letteragh Junction WB Merge Slip Road	40	50	110	150	350
GCTP-700-045	N84 Headford Road EB Diverge Slip Road	40	50	160	150	350
GCTP-700-046	N84 Headford Road EB Merge Slip Road	40	50	210	150	350
GCTP-700-047	N84 Headford Road WB Diverge Slip Road	40	50	240	150	350
GCTP-700-048	N84 Headford Road WB Merge Slip Road	40	50	160	150	350
GCTP-700-049	N83 Tuam Road EB Diverge Slip Road	40	50	170	150	350
GCTP-700-050	N83 Tuam Road WB Merge Slip Road	40	50	250	150	350
GCTP-700-051	Parkmore Link Road WB Diverge Slip Road	40	50	110	150	350
GCTP-700-052	Parkmore Link Road EB Merge Slip Road	40	50	110	150	350
GCTP-700-053	Coolagh EB Merge Slip Road	40	50	250	150	350
GCTP-700-054	Coolagh EB Diverge Slip Road	40	50	220	150	350
GCTP-700-055	Coolagh WB Merge Slip Road	40	50	190	150	350
GCTP-700-056	Coolagh WB Diverge Slip Road	40	50	230	150	350
GCTP-700-057	Monivea Road R339 East	40	50	130	150	400
GCTP-700-058	Ballybrit Crescent Road	40	50	180	150	400
GCTP-700-059	Briarhill Business Park Overlay	40	50	120	150	400

6.2.3 Pavement Type

The pavement build ups have been categorised and designed conservatively using the maximum MSA values for the single and dual carriageway mainline sections and also for the associated link and slip roads. Details are provided in **Table 6.3** Consideration of the environmental noise mitigation requirements is required when selecting an appropriate surface course material. A Polymer Modified Stone Mastic Asphalt surface course generates lower noise levels by up to -2.5dB when compared with alternative pavement types such Hot Rolled Asphalt, therefore a Polymer Modified Stone Mastic Asphalt has been specified for the proposed road development. The pavement build up for proposed widening and overlay sections on existing roads will depend on site specific conditions such as subgrade CBR, existing pavement and granular thickness. Refer to Drawings **GCOB-700-D-000** to **015** in **Volume 2** for further details.

Table 6.3: Summary of Pavement Build-up

Pavement Type & Location	Pavement Build Up
Type A: N6 Type 1 Single Carriageway. R336 Bearna to Ballymoneen Road (25 MSA)	40mm SMA 14 surf PMB 65/105-60 des
	50mm AC20 dense bin Binder Course (40/60 rec)
	200mm AC32 dense base Base Course (40/60 rec)
	Sub-base (150mm thick granular Type B)
Type B: N6 Urban Motorway Dual Carriageway Ballymoneen Road to N6/M6 (116 MSA)	40mm SMA 14 surf PMB 65/105-60 des
	50mm AC20 dense bin Binder Course (40/60 rec)
	260mm AC32 dense base Base Course (40/60 rec)
	Sub-base (150mm thick granular Type B)
Type C: N59 & Parkmore Link Road (22 MSA)	40mm SMA 14 surf PMB 65/105-60 des
	50mm AC20 dense bin Binder Course (40/60 rec)
	190mm AC32 dense base Base Course (40/60 rec)
	Sub-base (150mm thick granular Type B)
Type D: Slips Road (61 MSA)	40mm SMA 14 surf PMB 65/105-60 des
	50mm AC20 dense bin Binder Course (40/60 rec)
	250mm AC32 dense base Base Course (40/60 rec)
	Sub-base (150mm thick granular Type B)
Type E: Access Roads and Farm Accesses (1 MSA)	Double surface dressing
	Sub-base (150mm thick granular Type B)
Type F: Carpark - Bound (0.5MSA)	35mm AC10 close surf 160/220 des
	75mm AC 20 dense bin 70/100 des
	Sub-base 300mm Granular Material, Type B

Pavement Type & Location	Pavement Build Up
Type G: Carpark - Unbound	40mm Stabilised Granular Material (Max 14mm Chip)
	Geotextile Membrane Layer set in 20mm Sharp Sand Layer
	Compacted Subgrade – Minimum 3.0 CBR (May require thin layer of hardcore – Granular CL804 Type B)

6.2.4 High Friction Surfacing & Fuel Resistant Surfacing

High friction surfacing shall be provided as per AM-PAV-06045 (HD 28) and be designed in accordance with Series 900.

i. A minimum length of 50m of high friction surfacing shall be provided to all lanes in advance of the give way line on all arms of the Bearna West and Bearna East Roundabouts.

ii. A minimum length of 50m of high friction surfacing shall be provided to all lanes in advance of the stop line on all arms of the proposed signalised junctions. Refer to **Chapter 4, Junction Strategy** for locations of signalised junctions. Where the traffic signals incorporate pedestrian facilities the high friction surfacing shall be continued to the first line of crossing studs.

The surface course provision in bus lay-bys, lay-bys and other paved areas that will be utilised by commercial vehicles shall be resistant to diesel spillage (UK DMRB HD 26/06 – Cl 2.46).

6.3 Summary

A fully flexible pavement design for a 40-year design life has been completed in accordance with PE-SMG-02002 and DN-PAV-03021. As presented above there are two distinct categories of pavement thicknesses required for the N6 GCRR mainline. The first is for the Single Carriageway section and the second for Dual Carriageway. As the design is progressed through tender and the construction phase, there may be an option to change to flexible composite design depending on the requirements of the appointed contractor while still fulfilling the requirements of the Environmental Impact Assessment. The final selection of the preferred pavement option for each road feature will be made in the Detailed Design phase of the project and approval will be sought from the relevant roads authority.

7 Structures

7.1 General

A number of structures are proposed along the length of the proposed road development. The structures shall be designed in accordance with Transport Infrastructure Ireland (TII) Publications and the Manual of Contract Documents for Road Works (MCDRW).

The design of structures is developed to a level of detail sufficient to describe the major elements of the structure and obtain preliminary approval in accordance with DN-STR-03001 Technical Acceptance of Road Structures on Motorways and Other National Roads (Formerly NRA BD 2). This chapter of the report provides an overview of the structures envisaged, and are presented in more detail in the Preliminary Design Reports listed in **Table 7.1** below. The preliminary design reports and associated drawings are contained in **Appendix A.7**.

Table 7.1: Structures Preliminary Design Report Schedule

Structure or Structure Group	**Reference**	**Appendix**
Standard Overbridges	GCOB-4.04-020-002	A.7.1
Standard Underbridges	GCOB-4.04-020-003	A.7.2
Galway Racecourse Tunnel	GCOB-4.04-020-009	A.7.3
Menlough Viaduct	GCOB-4.04-020-010	A.7.4
Lackagh Tunnel	GCOB-4.04-020-001	A.7.5
River Corrib Bridge	GCOB-4.04-020-012	A.7.6
Culverts and Underpasses	GCOB-4.04-020-013	A.7.7
Other Structures (Retaining Structures, Sign Gantries and Environmental Noise Barriers)	GCOB-4.04-020-014	A.7.8

Where appropriate, structures with similar functionality and configuration are grouped together as a Structure Group, such as *Standard Overbridges*. In other cases, where a structure is of particular significance, it is described and presented independently, such as *River Corrib Bridge*.

The structure locations and references are given in the scheme layout drawings (**GCOB-000-D-000** to **015** in **Volume 2**). Details of the structure general arrangements is presented in the Series 1700 Drawings.

7.2 Standard Structures

7.2.1 Standard Overbridges

The Standard Overbridges structure group consists of 7 bridge structures which cross over the proposed N6 GCRR. The bridge structures and their location is given in **Table 7.2** below.

Table 7.2: Standard Overbridges and Mainline Chainage locations

Name of Structure	Chainage
S01/01- Foraí Maola to Troscaigh Link Overbridge	01+375
S03/01 - Barr Aille Overbridge	03+300
S12/02 - Castlegar Wildlife Overbridge	12+700
S13/01 - School Road Overbridge	13+185
S14/01 - Parkmore Link Road Overbridge	14+375
S16/01 - Coolagh Junction Overbridge (EB diverge to R446)	16+410
S16/02 - Coolagh Junction Overbridge (EB merge from R446)	16+830

A summary of the overbridge structures is provided below, and general arrangement information is presented in **Table 7.3**.

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 an overbridge (green bridge) to facilitate mammal crossing over the proposed road development.

Structures S16/01 and S16/02 are overbridges required at the grade separated Coolagh Junction to provide free flow access between the R446 and the proposed road development.

Table 7.3: Standard Overbridges General Arrangements

Structure Reference	Span arrangement	Typical Span Lengths (m)	Skew angle (deg)	Deck Width (m)
S01/01	3 Span	10.7 + 17.4 + 10.7	0	11.2
S03/01	3 Span	12.5 + 19.1 + 12.5	24	10.6
S12/02	2 Span	25.2 + 23.9	0	30.0
S13/01	2 Span	39.2 + 35.9	28	11.5
S14/01	3 Span	25.51 + 32.41 +34.16	29	17.25
S16/01	4 Span	28.0 + 32.7 + 28.5 + 21.6 [1]	0	14.6
S16/02	4 Span	19.0 + 37.4 + 32.3 + 16.0 [2]	58	Varies 14.8min

[1] Average span length due to curved bridge deck and varying support line orientation.

[2] Average span length given; deck width varies along the length of the bridge.

At all the proposed overbridge structures, competent rock is expected at or near the foundations, thus the abutments and central piers will be supported on spread foundations. Where necessary, compacted 6N upfill will be provided between the foundation and the natural ground strata below, to achieve the required bearing capacity.

Typical elevations of the overbridges are given in **Figures 7.1** to **7.3** below.

Figure 7.1: 2-Span Overbridge

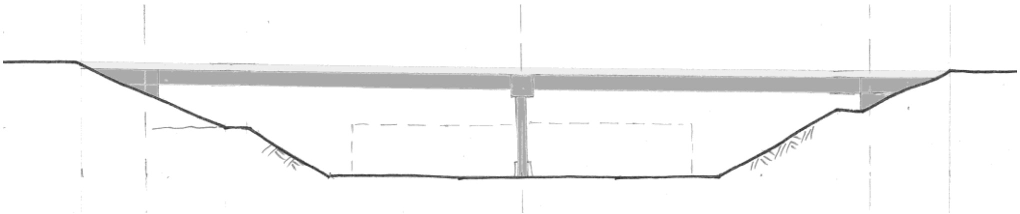


Figure 7.2: 3-Span Overbridge

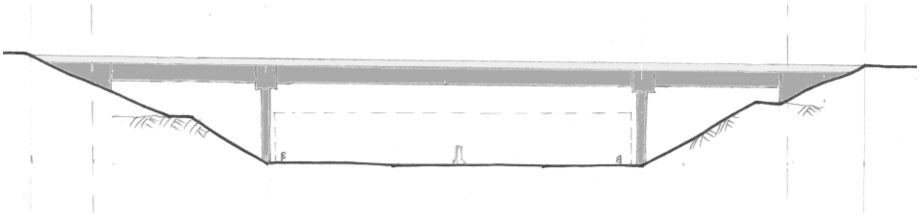
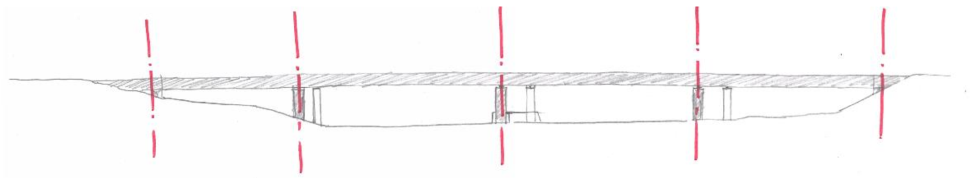


Figure 7.3: 4-Span Overbridge



At some locations, there is a medium to high risk of karst features in the ground. Where these occur, appropriate measures will be necessary for the bridge foundations. The measures shall be in accordance with the Karst Protocol methods outlined in **Chapter 5, Ground Conditions, Topography & Earthworks**.

7.2.2 Standard Underbridges

The Standard Underbridges structure group consists of 10 bridge structures which enable roads to pass under the proposed road development. The bridge structures and their location are given in **Table 7.4** below.

Table 7.4: Standard Underbridges and Mainline Chainage locations

Name of Structure	Chainage
S06/01 - Rahoon Road Underbridge	06+335
S07/01 - Letteragh Road Underbridge	07+290
S07/02 - N59 Link Road Underbridge	07+570
S08/02 - N59 Moycullen Road Underbridge	08+540
S09/01 - Menlo Castle Bóithrín Underbridge	09+730
S10/02 - Seanbóthar Underbridge	10+520
S12/01 - N84 Headford Road Underbridge	12+150
S13/02 - N83 Tuam Road Underbridge	13+975
S15/01 - Briarhill Business Park Underbridge	15+725
S15/02 – R339 Monivea Road Underbridge	15+880

The standard underbridges are sub-divided into two structure types, namely Underbridge Type 1 and Underbridge Type 2. A summary of the underbridge structures is provided below, and general arrangement information is presented in **Table 7.5**, **Table 7.6** and **Table 7.7**.

7.2.2.1 Underbridge Type 1: Buried reinforced concrete box structure

The Type 1 underbridge structure comprises a buried reinforced concrete box structure. The box is made from pre-cast concrete units which are placed together to form a buried box construction. The typical elevation of this form of underbridge type is given in **Figure 7.4**. This type of structure is typically utilised at locations where the span is less than 14.5m and the road being crossed is a local road. A summary of the Type 1 underbridges is provided in **Table 7.5** below.

Figure 7.4: Underbridge Type 1

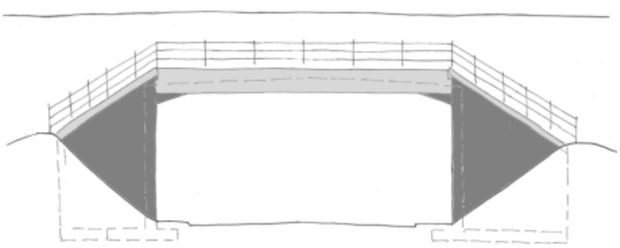


Table 7.5: General Arrangements for Underbridge Type 1

Name of Structure	Span arrangement	Clear span (m)	Length of structure (m)
S06/01 - Rahoon Road Underbridge	1 Span	12.5	52.0
S07/01 - Letteragh Road Underbridge	1 Span	12.5	71.0
S09/01 - Menlo Castle Bóithrín Underbridge	1 Span	10	37.0
S10/02 - Seanbóthar Underbridge	1 Span	9.8	49.0

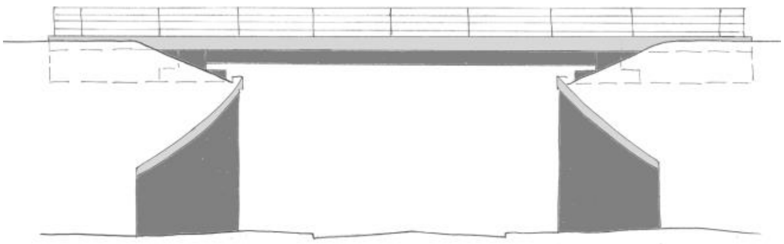
7.2.2.2 Underbridge Type 2: Bridge deck with reinforced earth wall abutment

A Type 2 underbridge comprises a bridge deck with reinforced earth wall abutments. For spans greater than 14.5m, and where vertical abutment walls are considered appropriate, then a bridge deck with reinforced earth wall abutments is adopted. Depending on the span and skew of the bridge deck, two sub-categories of bridge Type 2 are specified. A description of the sub-categories is outlined below:

- **Type 2A:** The deck consists of pre-cast concrete beams which is made integral with abutment bankseats which are supported directly on reinforced earth walls, which form the abutment construction. The skew of the bridge deck is less than

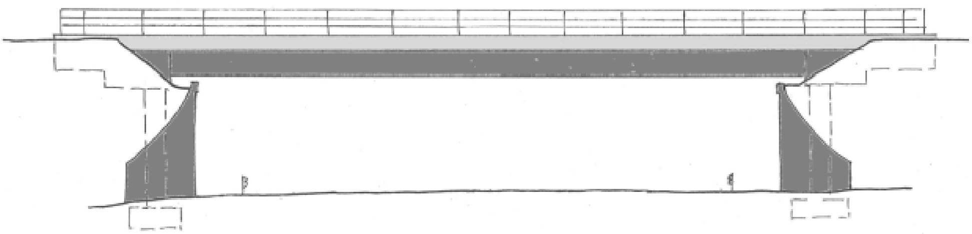
30 degrees and the clear span between abutment bankseats is less than 18m. The typical elevation of this form of underbridge type is given in **Figure 7.5**.

Figure 7.5: Underbridge Type 2A



- **Type 2B:** The deck consists of pre-cast concrete beams which is made integral with skeletal abutments constructed within the reinforced earth wall system. The skew of the bridge deck is less than 30 degrees and the clear span between abutment bankseats is greater than 18m. The typical elevation of this form of underbridge type is given in **Figure 7.6**.

Figure 7.6: Underbridge Type 2B



A summary of the general arrangement information for Underbridge Type 2 structures is given **Table 7.6** below.

Table 7.6: General Arrangements for Underbridge Type 2

Name of Structure	Span arrangement	Span (m)	Structure skew (deg)	Deck Width (m)
S07/02 - N59 Link Road Underbridge	1 Span (Type2B)	27.0	6	23.8
S12/01 - N84 Headford Road Underbridge	1 Span (Type2B)	23.4	4	32.9
S13/02 - N83 Tuam Road Underbridge	1 Span (Type2B)	32.6	30	45.4
S15/01 - Briarhill Business Park Underbridge	1 Span (Type2A)	15.5	8	25.1
S15/02 – R339 Monivea Road Underbridge	1 Span (Type2B)	26.6	6	31.6

7.2.2.3 Underbridge Type 3: Concrete deck with side slopes (1:1.5)

A Type 3 underbridge comprises a concrete deck with bankseat abutments founded within the mainline embankment. In this situation a more open arrangement is preferred and the width of the road being crossed is not significant, thus a single span bridge with side slopes is adopted. To reduce the overall span of the bridge, side slopes with an inclination of 1.5 horizontal to 1.0 vertical is adopted.

The deck consists of precast beams and an in-situ deck slab, made integral with bankseat abutments. The typical elevation of this form of underbridge type is given in **Figure 7.7**.

A summary of the general arrangement information for Underbridge Type 3 is given in **Table 7.7**.

Figure 7.7: Underbridge Type 3

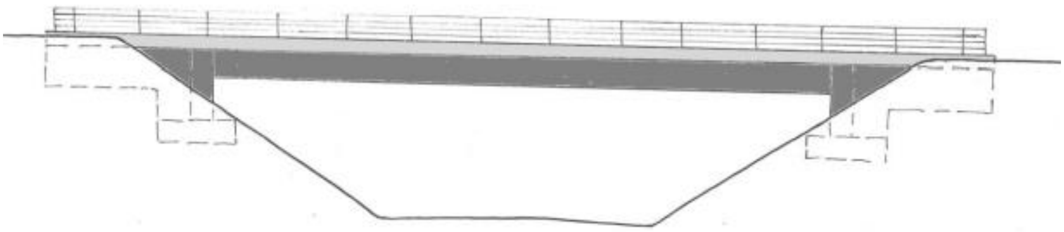


Table 7.7: General Arrangements for Underbridge Type 3

Name of Structure	**Span arrangement**	**Span (m)**	**Structure skew (deg)**	**Deck Width (m)**
S08/02 - N59 Moycullen Road Underbridge	1 Span	32.5	30	27.5

7.2.2.4 Foundations

At all the proposed underbridge structures, competent rock is expected at or near the foundations. Where necessary, compacted 6N upfill will be provided between the foundation and the natural ground strata below to achieve the required bearing capacity.

At some locations there is a medium to high risk of karst features in the ground. Where these occur, appropriate measures will be necessary for the bridge foundations. The measures shall be in accordance with the Karst Protocol methods outlined in **Chapter 5, Ground Conditions, Topography & Earthworks**.

7.2.3 Culverts & Underpasses

The Culverts & Underpasses structure group consists of 28 structures. The location and function of the structures is given in **Table 7.8** below.

Table 7.8: Culverts and Underpasses

Name of Structure	Chainage	Function
C00/01	00+670	Combined Hydraulic Culvert + Mammal Underpass
C02/01a	02+800	Hydraulic Culvert
C02/01b	02+850	Combined Hydraulic Culvert + Mammal Underpass
C03/01	03+070	Combined Hydraulic Culvert + Mammal Underpass
C03/03	03+945	Combined Hydraulic Culvert + Mammal Underpass
C03/04	03+965	Combined Hydraulic Culvert + Mammal Underpass
C04/01	04+120	Combined Hydraulic Culvert + Mammal Underpass
C04/02	04+915	Combined Hydraulic Culvert + Mammal Underpass
C06/00	06+450	Mammal Underpass
C06/01	06+850	Combined Hydraulic Culvert + Mammal Underpass
C07/00	07+100	Mammal Underpass
C07/02a	07+225	Combined Hydraulic Culvert + Mammal Underpass
C08/01a	08+450	Mammal Underpass
C08/02	08+650	Mammal Underpass
C08/04	08+580	Mammal Underpass
C08/05	08+620	Mammal Underpass
C09/01	09+530	Mammal Underpass
C09/02	09+545	Mammal Underpass
C09/03	09+560	Mammal Underpass
C09/04	09+575	Mammal Underpass
C09/05	09+590	Mammal Underpass
C09/06	09+790	Mammal Underpass
C09/07	09+920	Mammal Underpass
C10/01 –Environmental underpass	10+040	Environmental underpass spanning over exposed limestone pavement
C12/02	12+375	Mammal Underpass
C12/03	12+410	Mammal Underpass

Name of Structure	Chainage	Function
C12/04	12+435	Mammal Underpass
C13/01	12+980	Mammal Underpass

Buried reinforced concrete structures are provided at all of the culverts and underpasses. The structural forms of the proposed culverts will be one of three types, namely a box, an arch or a portal frame as indicated in **Figures 7.8** and **7.9** below.

Figure 7.8: Box Structure

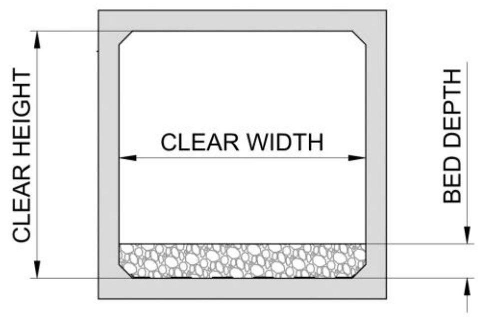
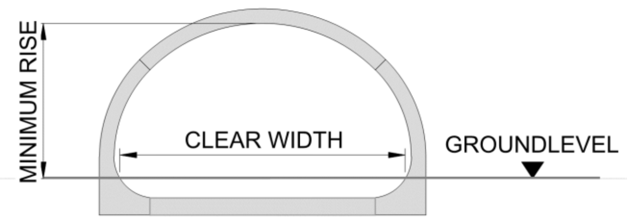


Figure 7.9: Arch Structure



7.2.4 Hydraulic Culverts and Mammal Underpasses

At some locations, the structure has a combined function of both a hydraulic culvert and mammal underpass. For these structures with a span greater than 2m, a buried box or buried arch structure is provided. At locations where the cover to the top of the structure is greater than 7m, a buried arch structure is provided, for the remaining structures a buried box configuration is selected.

All hydraulic culverts have a base slab and a bed depth allowance. The culverts have been sized based on the required hydraulic capacity outlined in the Section 50 application process i.e. capacity 1% Annual Exceedance Probability (AEP) storm plus an allowance for climate change. In addition to this at some locations, the size of the culverts have been increased to incorporate mammal passage requirements for example bats, badgers and otters.

Note that only hydraulic culverts classified as a structure in accordance with TII DN-STR-03001 (NRA BD 2) are presented in this section. Refer to the **Chapter 8, Drainage, Hydrology & Flood Risk** of this Design Report for details of other, smaller, culverts.

For the multiple mammal underpasses, C09/01 to C09/05, located at the eastern approach to the River Corrib Bridge, multiple arches (5 no.) are proposed with a clear width of 5m and a height of 4m.

A summary of the general arrangements for buried box structures is provided in **Table 7.9**. A summary of the general arrangements for buried arch structures is provided in **Table 7.10**.

Table 7.9: Box Culverts

Name of Structure	Clear Width (m)	Clear Height (m)	Bed Depth (m)
C00/01	2.5	1.35	0.30
C02/01a	2.1	1.8	0.30
C02/01b	2.5	2.5	0.30
C03/01	2.5	1.2	0.30
C03/03	2.5	2.5	0.30
C03/04	2.5	2.5	0.30
C04/01	5.0	2.5	0.30
C04/02	3.1	2.5	0.30
C06/00	2.5	2.5	n/a
C06/01	2.5	2.5	0.30
C07/00	2.5	2.0	n/a
C08/01a	2.5	2.5	0.15
C08/02	2.5	2.5	0.70
C08/04	2.5	2.5	n/a
C08/05	2.5	2.5	n/a
C13/01	2.5	1.5	n/a

Table 7.10: Buried Arch Structures

Name of Structure	Clear Width (m)	Minimum Rise (m)	Bed Depth (m)
C07/02a	2.5	2.5	0.30
C09/01	5.0	4.0	n/a
C09/02	5.0	4.0	n/a
C09/03	5.0	4.0	n/a
C09/04	5.0	4.0	n/a
C09/05	5.0	4.0	n/a
C09/06	2.5	2.5	n/a
C09/07	2.5	2.5	n/a
C12/02	2.5	2.5	n/a
C12/03	2.5	2.5	n/a
C12/04	2.5	2.5	n/a

7.2.5 Environmental Underpass

At chainage 10+040 an underpass structure (C10/01) is proposed to carry the mainline over an area of exposed limestone pavement. The general arrangement details of the proposed environmental underpass is provided in **Table 7.11** below.

Table 7.11: Environmental Underpass

Name of Structure	Span arrangement	Span (m)	Structure skew (deg)	Deck Width (m)
C10/01	1 Span	20.0	4	26.9

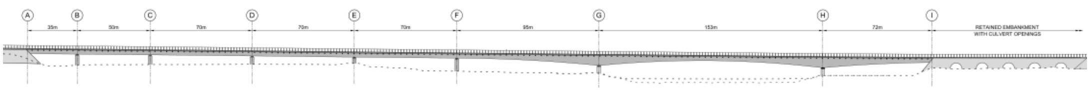
7.3 Major Structures

7.3.1 River Corrib Bridge - S08/04

The River Corrib Bridge carries the N6 GCRR over the River Corrib. The River Corrib bridge crossing is situated to the north of Galway City Centre, adjacent to Menlo Castle and traversing NUIG Sporting Campus and the Lough Corrib candidate Special Area of Conservation (cSAC).

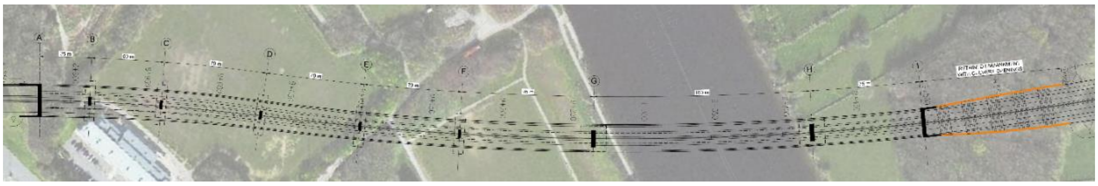
The proposed structure comprises of an 615m long eight span bridge (35m-50m-70m-70m-70m-95m-153m-72m) carrying the proposed road development over the River Corrib, as indicated in **Figure 7.10** below. The proposed structure is a variable depth single concrete box without supports in the river. The structural depth varies across the 153m main span, from approximately 7m near the supports and reducing to approximately 3m at mid-span. Spans adjacent to the river crossing span consist a variable depth single concrete box increasing in depth from 3m to 7m on approach to the main span. The remaining approach spans to the west consists of 3m constant depth single box girder deck. The superstructure will be supported on reinforced concrete piers.

Figure 7.10: Elevation of River Corrib Structure



The plan alignment of the bridge is curved as shown in **Figure 7.11**.

Figure 7.11: Plan View of River Corrib Structure



As a result of the curved alignment there are sections along the length of the bridge where the deck needs to be widened to accommodate sightlines for forward visibility and stopping sight distances. The minimum deck width is 21.7m and the maximum deck width is 24.9m (**Figure 7.12**), widening of the hardshoulder lane is provided where required for sightlines.

Figure 7.12: Superstructure Cross-Section at River Crossing

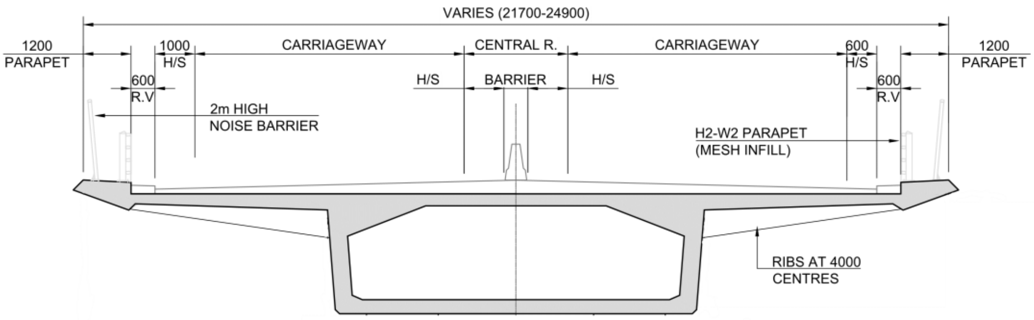


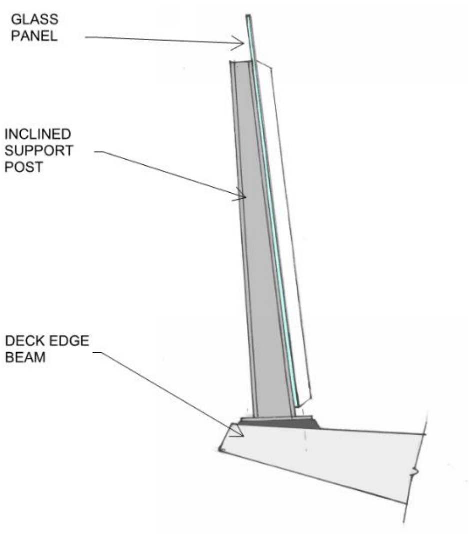
Table 7.12: Dimensions on Bridge Deck (all Dimensions Measured Perpendicular to the Mainline)

Name of Structure	Carriageway Width [1] (m)	Verge Width (m) - Left	Verge Width (m) - Right	Parapet width (m) [Left]	Parapet width (m) [Right]
River Corrib Crossing	18.1 – 21.3	0.6	0.6	1.2	1.2

[1] Carriageway width measures from outer edge of hardshoulders and includes width of central reserve

The bridge deck superstructure will be continuous. It will be supported on bearings at intermediate supports and abutment bank seats. Expansion joints are proposed at either end of the structure. Inspection galleries will be provided at each abutment for the inspection of bearings and expansion joints. The bridge incorporates a transparent 2m high noise barrier (refer to **Figure 7.13**).

Figure 7.13: Edge detail – Noise Barrier



The general ground conditions consist of firm to stiff cohesive glacial till, mixed with granular till, with the vast majority of the area underlain by very strong limestone. The bridge intermediate support foundations will consist of reinforced concrete piles supported on rock.

7.3.2 Menlough Viaduct – S10/01

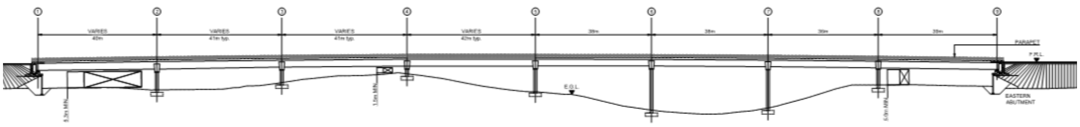
The Menlough Viaduct carries the proposed road development over an area of exposed limestone pavement and turlough. The total length of the bridge is governed by the extent of priority Annex I habitat.

The proposed Menlough Viaduct consists of a 320m, 8-span continuous bridge deck. The distance between the soffit of the superstructure and the ground level varies. A minimum clearance of approximately 1.5m occurs at the location of the high point in the rock outcropping on the western side of the structure at Chainage Ch. 10+215.

The bridge deck superstructure will consist of prefabricated precast prestressed beams with a cast in-situ concrete deck slab. 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. The position of the substructure and foundations will minimise the impact on the priority Annex I habitats. No substructure supports are proposed within the extents of a Turlough in the area.

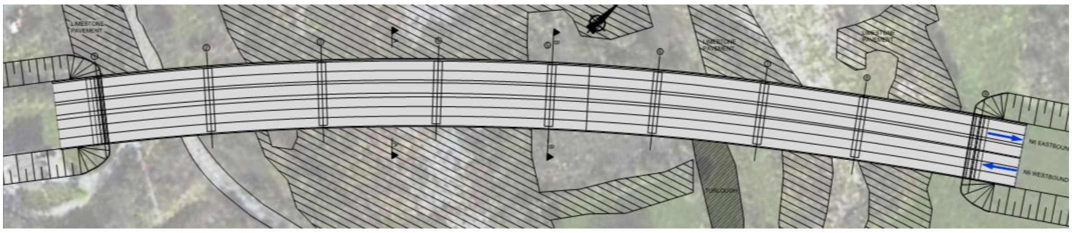
The viaduct contains 8 spans, with a typical length of approximately 40m. The proposed span lengths and configuration has been selected to reduce the impact of the substructure and foundations on the ecological constraints in the area.

Figure 7.14: Elevation of Menlough Viaduct



The plan alignment of the bridge is curved as shown in **Figure 7.15**.

Figure 7.15: Plan View of Menlough Viaduct



As a result of the curved alignment the deck needs to be widened to accommodate sightline stopping distances. The minimum deck width is 24.5m (**Figure 7.16**), widened where required for sightlines.

Figure 7.16: Superstructure Cross-Section at Menlough Viaduct Crossing

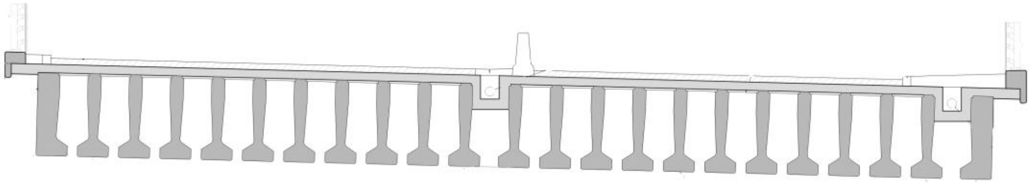


Table 7.13: Dimensions on Bridge Deck (all Dimensions Measured Perpendicular to the Mainline)

Name of Structure	Carriageway Width (m) [1]	Verge Width (m) Eastbound	Verge Width (m) Westbound	Parapet width (m) Eastbound	Parapet width (m) Westbound
Menlough Viaduct	19.3 – 21.1	0.6	0.6	0.5	0.5

[1] Carriageway width measures from outer edge of hardshoulders and includes width of central reserve

The bridge deck superstructure will be continuous. It will be supported on bearings at the abutments and at some of the intermediate supports; at the remaining intermediate supports the superstructure will be integral with the support. Expansion joints are proposed at either end of the structure. Inspection galleries will be provided at each abutment for the inspection of bearings and expansion joints.

The substructure will consist of conventional reinforced concrete piers at intermediate supports while the reinforced concrete skeletal abutments within reinforced earth walls will be provided at the end supports. The position of the substructure and foundations will minimise the impact on the priority Annex I habitats. No substructure supports are proposed within the extents of the Turlough.

Based on available information, the general ground conditions consist of areas of soft to stiff cohesive glacial till underlain by limestone or outcropping Limestone pavement. The rock is medium strong with medium to closely spaced discontinuities and non-intact zones.

The bridge foundations will consist of foundation pads situated on weathered rock, competent rock or soil.

7.3.3 Lackagh Tunnel and Western Approach – S11/01

The proposed road development passes through a disused quarry, under a section of Limestone pavement 3km North West of Galway City in the townland of Coolagh. The area around the Western Approach and Lackagh Tunnel are part of the Lough Corrib cSAC.

The primary function of Lackagh Tunnel and Western Approach is to avoid adverse ecological impacts on the Lough Corrib candidate Special Area of Conservation (cSAC). The proposed road development tunnels beneath the Lough Corrib cSAC and the Western Approach passes between it. The maximum tunnel length is 270m with the Western Approach 330m in length.

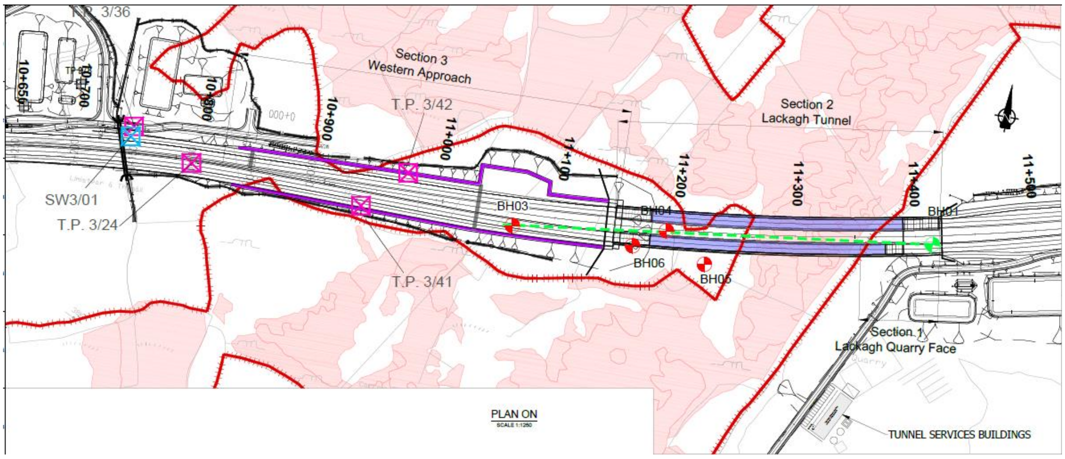
Groundwater data indicates that there is a groundwater divide between Lackagh Quarry and Coolagh lakes, based on this divide the groundwater at Lackagh Quarry will drain south-eastwards away from Coolagh Lakes and groundwater near Menlough will drain south-westwards towards Coolagh Lakes. In the design this is a key consideration to the maintenance of this groundwater catchment separation.

The Lackagh Tunnel and Western Approach consist of the following structural elements:

- Lackagh Quarry Portal: Located on the eastern side of the Lackagh Tunnel and forms the entrance to the tunnel. It will be designed to the winter high water level to prevent any ingress of flood water into the tunnel
- Lackagh Tunnel: Connects Lackagh Quarry to the Western Approach and comprises twin mined tunnels for the eastbound and westbound carriageways. Each tunnel bore comprises a 12.5m (circa) wide span tunnel with watertight concrete arch lining with the internal elements (road, walkways, lighting, ventilation etc.) placed within this shell. At the western end of the tunnel, where the depth of overburden increases, it is expected that there will be a transition construction from the mined tunnel to the Western Approach structure. This transition structure is likely to consist of a pair of concrete box structures, constructed using cut and cover methods
- Western Approach: Connects Lackagh Tunnel to Menlough and is formed from U-shaped trough structures which provide a water cut off and minimise the impact to the Lough Corrib cSAC. The top of retaining walls range from 17.7mOD to 21.7mOD

The plan layout of the Lackagh Tunnel and Western Approach is given **in Figure 7.17** below.

Figure 7.17: Plan View of Lackagh Tunnel and Western Approach



The internal span of the mined tunnels is expected to be approximately 12.5m, to accommodate the 10.9m road cross-section, and a length of 270m, transitioning from rock through an approximately 30m long transition box structure. The transition box structure will have internal spans of approximately 10.9m. The trough structure in the western approach will vary in width up to 38m and 330m in length at varying depths.

The typical cross-section of the mined tunnels, transition structure and the trough structure are shown in **Figures 7.18** to **7.20** below.

Figure 7.18: Cross-section of mined tunnels

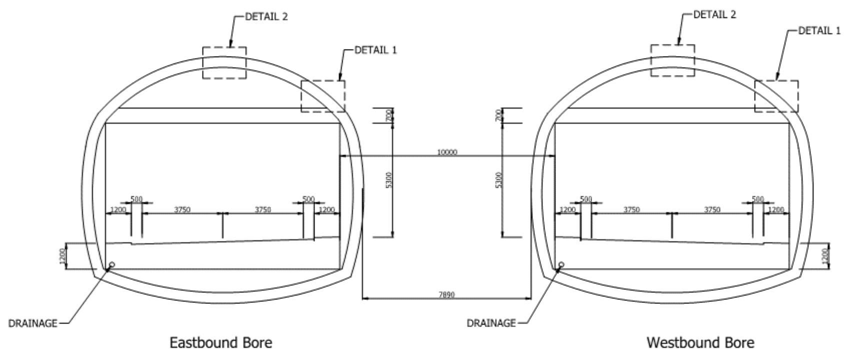


Figure 7.19: Cross-section of transition structure

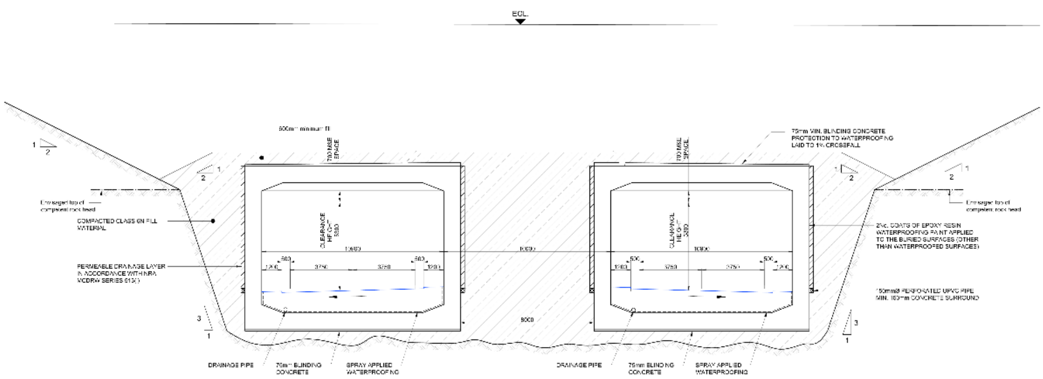
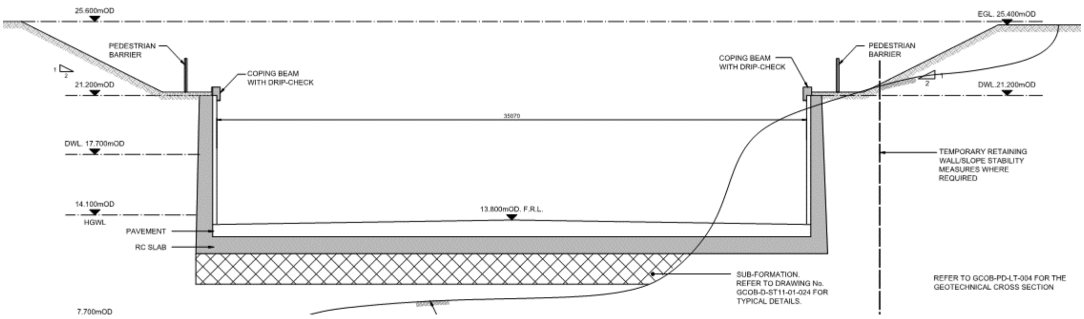


Figure 7.20: Cross-section of trough structure



The founding strata for Lackagh Tunnel will be entirely founded on limestone bedrock which provides an extremely stiff and stable founding material. The founding strata for the transition structure will vary between limestone bedrock to cobbles and boulders to stiff glacial till. The founding strata for the western approach varies from an east to west direction between stiff glacial till becoming soft organic clay and transitioning again into glacial till to cobbles and boulders to limestone bedrock.

Along the Western Approach u-trough structure and the transition structure, the balance between the weight of the structure, the buoyancy due to the high ground water table and the movements associated with the seasonal variation in water levels means that measures to prevent uplift will be required. It is envisaged that the use of ballast, rock anchors and tension piles are potential foundation options for the approach structure.

The Lackagh Tunnel will effectively have strip foundations acting at the edge of the tunnel structure which will be supported by the bedrock. Where local weak zones or karst features are encountered in the founding zone then appropriate measures will be undertaken to provide the required support to the structure.

The tunnel services, monitoring and maintenance building will be located on the south side of the eastern portal of the tunnel in Lackagh Quarry. The building will house operations personal and tunnel plant and equipment.

The mechanical services in the tunnel shall comprise of:

- Emergency points
- Tunnel Ventilation (Natural)
- Fire Fighting Hydrant Main
- Portable First Aid Fire Extinguishers
- Mechanical Services to the Tunnel Services Building and Plant Rooms

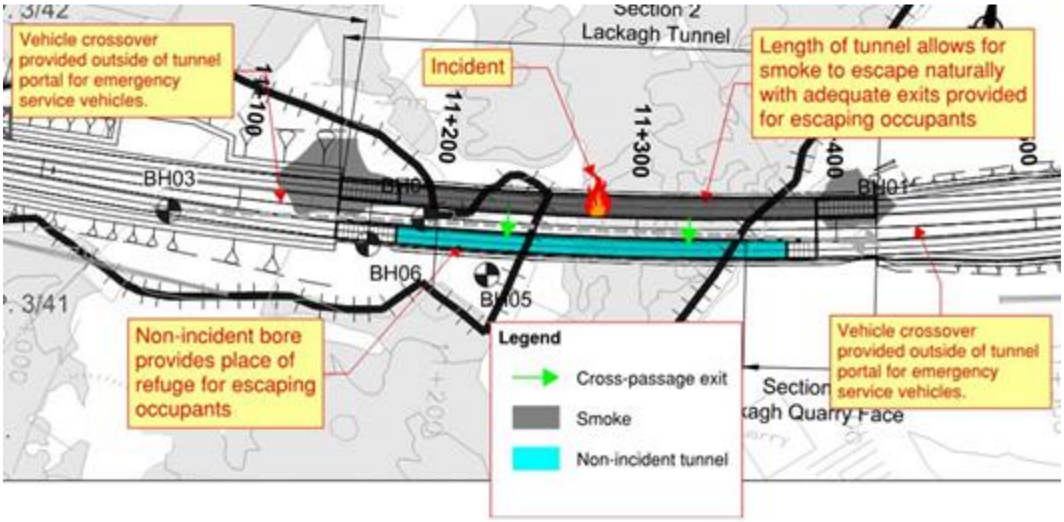
The electrical services in the tunnel shall comprise of:

- Complete Power Distribution System
- Standby Power System
- Tunnel Lighting
- Emergency Lighting
- Fire Detection
- Cable Containment and Support
- Electrical Infrastructure to Traffic Control, Communications and Information Systems
- Electrical Services to Tunnel Services Buildings and Plant Rooms

The UK guidance document BD 78/99 *Design of Road Tunnels* has been used as the main fire engineering guidance document with due cognisance of the risk-based criteria outlined in the EU Directive (2004/54/EC). This guidance document is relevant to all tunnels > 150 m in length.

In the unlikely event that occupants do need to evacuate in the case of fire, they can do so via the portals or via cross-passage doors into the adjacent tunnel bore from where they can walk to one of the portals or await rescue, as indicated in the **Figure 7.21** below.

Figure 7.21: Lackagh Tunnel - Means of Escape



It is currently proposed to provide cross-passage every 100 m in accordance with TII DN-STR-03015 (BD78/99). Walkways will be provided on both sides of the tunnel to allow evacuating occupants to access the cross-passage escape doors.

Other tunnel safety systems which will contribute to the management of the tunnel and therefore assist in maintaining adequate levels of safety are as follows:

- CCTV
- Traffic control measures
- Fire detection
- PA system
- Emergency Lighting System
- Signage

Refer to **Chapter 10, Traffic Signs, Lighting & Communication** for further information on the communication strategy within proposed tunnels.

7.3.4 Galway Racecourse Tunnel – S14/02

The proposed road development passes through the north eastern corner of Galway Racecourse property and necessitates a cut and cover tunnel at circa Ch. 14+950m to Ch. 15+190, resulting in a tunnel length of approximately 240m. The tunnel cross-section contains two bores, one for eastbound traffic and one westbound traffic separated by a central wall. The westbound bore requires a clear horizontal dimension of 13.0m and the eastbound bore requires a clear horizontal distance ranging from 11.95m to 13.45m. This is to cater for forward visibility and stopping sight distances as well as providing a minimum verge/walkways width of 1200mm.

Within the tunnel, the highway alignment provides a separation distance of 1.5m between adjacent walkways of the eastbound and westbound carriageways to facilitate the construction of a central wall. A minimum headroom clearance of 5.3m will be provided along the full length of the tunnel.

At the typical cross-section, the construction of this tunnel may consist of either twin box construction with all elements constructed using cast insitu reinforced concrete, as indicated in **Figure 7.22**, or precast concrete box units, which are assembled longitudinally and transversely from discrete precast elements, as shown in **Figure 7.23**.

Figure 7.22: Insitu reinforced concrete box typical cross-section

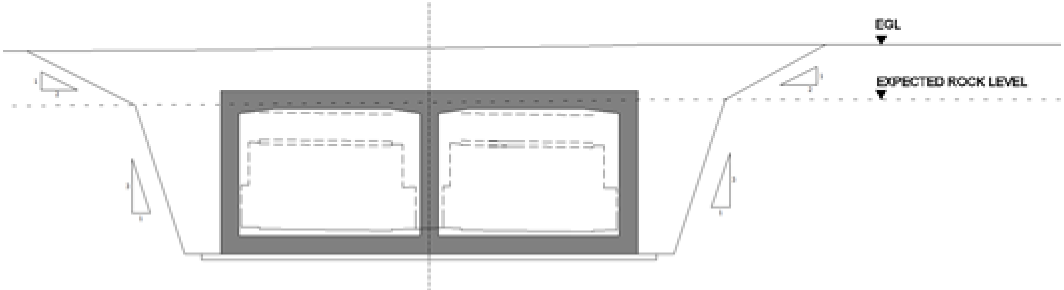
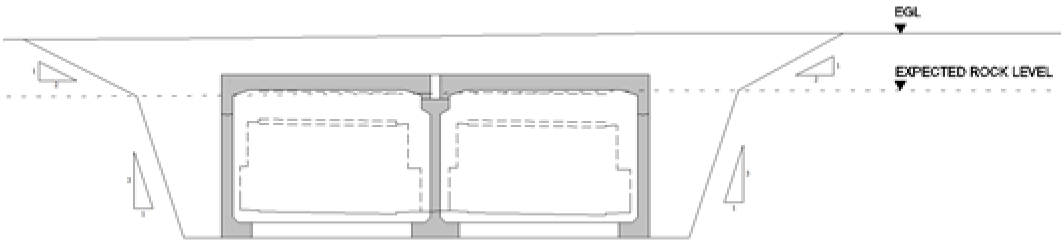


Figure 7.23: Precast concrete box typical cross-section



The general ground conditions consist of areas of soft to very stiff cohesive glacial till underlain by limestone. The rock is strong with medium to closely spaced discontinuities and non-intact zones.

It is envisaged that the base of the proposed buried twin tube reinforced concrete boxes will be situated within rock. It is proposed that the tunnel will be founded on compacted acceptable Class 6N material placed on rock. In addition, compacted Class 6N1 material will be placed behind the tunnel walls and a permeable drainage layer will be provided at the back of structural elements above the water table.

A tunnel services, monitoring and maintenance building shall be located above the tunnel and adjacent to the western tunnel portal. The building will house operations personal and tunnel plant and equipment.

The mechanical services in the tunnel will comprise of:

- Emergency points
- Tunnel Ventilation (Natural)
- Fire Fighting Hydrant Main
- Portable First Aid Fire Extinguishers
- Mechanical Services to the Tunnel Services Building and Plant Rooms

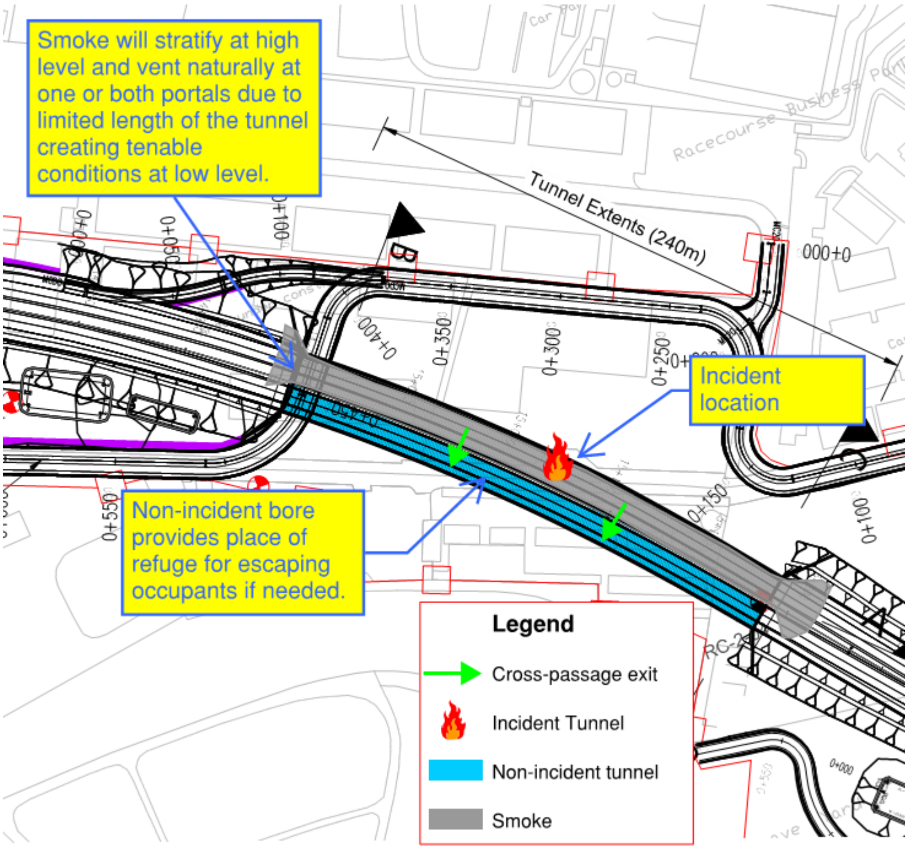
The electrical services in the tunnel will comprise of

- Complete Power Distribution System
- Standby Power System
- Tunnel Lighting
- Emergency Lighting
- Fire Detection
- Cable Containment and Support
- Electrical Infrastructure to Traffic Control, Communications and Information Systems
- Electrical Services to Tunnel Services Buildings and Plant Rooms

The UK guidance document BD 78/99 *Design of Road Tunnels* has been used as the main fire engineering guidance document with due cognisance of the risk based criteria outlined in the EU Directive (2004/54/EC). This guidance document is relevant to all tunnels > 150m in length.

In the unlikely event that occupants do need to evacuate in the case of fire, they can do so via the portals or via cross-passage doors into the adjacent tunnel bore from where they can walk to one of the portals or await rescue, as indicated in **Figure 7.24** below.

Figure 7.24: Galway Racecourse Tunnel - Means of escape



It is proposed to provide cross-passage doors every 100 m in accordance with TII DN-STR-03015 BD78/99. Walkways with a minimum width of 1.2m will be provided on both sides of the tunnel to allow evacuating occupants to access the cross-passage escape doors.

Other tunnel safety systems which will contribute to the management of the tunnel and therefore assist in maintaining adequate levels of safety are as follows:

- CCTV
- Traffic control measures
- Fire detection
- PA system
- Emergency Lighting System
- Signage

Refer to **Chapter 10, Traffic Signs, Lighting & Communication** for further information on communication strategy within proposed tunnels.

7.4 Other Structures

7.4.1 Retaining Structures

There are a number of retaining walls, mechanically stabilised earthworks and strengthened slopes envisaged along the length of the scheme. The location and type of structure is indicated in **Table 7.14** below.

Typically, where the structure is required to retain the proposed N6 roadway constructed on an embankment, the use of mechanically stabilized earth (MSE) systems are preferred. Elsewhere, reinforced concrete L-walls are adopted.

Where there is sufficient room available, strengthened slopes (reinforced earth embankments) are proposed. These slopes have an angle up to 70 degrees to the horizontal.

Table 7.14: Retaining structures

Name of Structure	Chainage	Structure Type	Length (m)	Retained Height (m)			Category
R04/01	04+450	Reinforced concrete L-wall	6	Varies	2.5	max	1
R08/01	08+325	MSE Wall	77	Varies.	7.0	max	2
R08/02	08+390	MSE wall	64	Varies.	6.5	max	2
R08/03a	08+475	Strengthened Slope	42	Varies.	5.5	max	2
R08/07	08+550	Strengthened Slope	128	Varies.	9.0	max	2

Name of Structure	Chainage	Structure Type	Length (m)	Retained Height (m)			Category
R08/08	0+100 (N59 Link Road)	Reinforced concrete L-wall	36	Varies	3.5	max	1
R08/09	0+075 (Moycullen Road)	Reinforced concrete L-wall	69	Varies	3.5	max	1
R09/01	09+510	Strengthened Slope	69	Varies.	7.5	max	2
R09/02	09+510	Strengthened Slope	73	Varies.	9.5	max	2
R09/03	09+825	Strengthened Slope	202	Varies.	6.5	max	2
R12/01	12+300	MSE Wall	110	Varies.	8.0	max	2
R14/03	14+550	Reinforced concrete L-wall	288	Varies.	2.5	max	1
R14/05	14+890	Reinforced concrete L-wall	33	Varies	3.0	max	1
R15/01	15+630	MSE Wall	66	Varies.	4.5	max	1
R15/02	15+750	MSE Wall	128	Varies.	7.0	max	2

7.4.2 Sign Gantries

The advanced directional sign gantries and variable messaging sign gantries for the proposed road development will adopt standardised configurations given in DN-STR-03010. A summary is provided in **Table 7.15** below. Location of all directional signs, variable messaging signs and Intelligent Transport Signs are presented on drawing series **GCOB-1500-D-001** to **015** in **Volume 2**.

Table 7.15: Sign Gantries

Name of Structure	Gantry Type	Approx. Chainage	Lateral Siting / Span	Comment
G06/01	Cantilever	06+260	Eastbound verge	Variable Message Sign
G06/02	Cantilever	06+950	Eastbound verge	Advance Directional Sign
G08/01	Cantilever	08+340	Westbound verge	Advance Directional Sign
G10/01	Cantilever	10+075	Eastbound verge	Variable Message Sign
G10/02	Portal	10+470	Across Eastbound lanes	Advance Directional Sign Intelligent Transport Sign

Name of Structure	Gantry Type	Approx. Chainage	Lateral Siting / Span	Comment
G10/03	Portal	10+600	Across Eastbound lanes	Intelligent Transport Sign
G10/04	Portal	10+840	Across Eastbound lanes	Advance Directional Sign Intelligent Transport Sign
G11/01	Portal	11+030	Across entire carriageway	Intelligent Transport Sign
G11/02	Portal	11+525	Across Westbound lanes	Intelligent Transport Sign
G11/03	Portal	11+600	Across Eastbound lanes +diverge	Directional Sign Intelligent Transport Sign
G11/04	Portal	11+775	Across Westbound lanes + merge	Intelligent Transport Sign
G12/01	Portal	12+060	Across Westbound lanes	Intelligent Transport Sign
G12/02	Portal	12+450	Across Westbound merge only	Advance Directional Sign
G12/03	Portal	12+725	Across all Westbound lanes	Directional Sign
G12/04	Portal	12+950	Across all Eastbound lanes	Advance Directional Sign Variable Message Sign
G13/01	Portal	13+190	Across all Westbound lanes	Advance Directional Sign Variable Message Sign
G13/02	Portal	13+450	Across Eastbound lanes +diverge	Directional Sign
G13/03	Portal	13+610	Across Westbound merge only	Advance Directional Sign
G14/01	Portal	14+250	Across Westbound lanes	Intelligent Transport Sign
G14/02	Portal	14+650	Across entire carriageway	Directional Sign Intelligent Transport Sign
G14/03	Portal	14+810	Across entire carriageway	Advance Directional Sign Intelligent Transport Sign

Name of Structure	Gantry Type	Approx. Chainage	Lateral Siting / Span	Comment
G15/01	Portal	15+290	Across entire carriageway	Advance Directional Sign Intelligent Transport Sign
G15/02	Portal	15+510	Across Westbound lanes	Intelligent Transport Sign
G15/03	Portal	15+690	Across Westbound lanes	Advance Directional Sign Intelligent Transport Sign Variable Message Sign
G15/04	Cantilever	15+820	Eastbound verge	Directional Sign
G15/05	Cantilever	15+925	Westbound verge	Variable Message Sign
G16/01	Portal	16+900	Across Westbound diverge only	Directional Sign
G17/01	Cantilever	17+320	Westbound verge	Directional Sign
G18/01	Cantilever	18+090	Westbound verge	Variable Message Sign

7.4.3 Environmental Noise Barriers

A summary of the proposed environmental noise barriers is given in **Table 7.16** below. Refer to Drawings **GCOB-300-D-001** to **015** in **Volume 2** for location of noise barriers.

Table 7.16: Environmental Noise Barriers

Structure Name	Start Chainage	End Chainage	Height (m)	Location	Lateral Siting
NB00/01	0+015	0+120	2.0	R336 West of Bearna West Roundabout	Westbound side
NB00/02	0+000	0+100	2.0	R336 East of Bearna West Roundabout	Eastbound side
NB01/01	1+030	1+145	2.0	Proposed Road Development Mainline	Eastbound side
NB01/02	1+520	1+735	2.0	Proposed Road Development Mainline	Westbound side
NB04/01	4+370	4+450	2.5	Proposed Road Development Mainline	Eastbound side
NB04/02	0+095	0+130	2.0	Cappagh Road North of Cappagh Road Junction	Northbound side
NB04/03	0+080	0+090	2.0	Cappagh Road North of Cappagh Road Junction	Northbound side

Structure Name	Start Chainage	End Chainage	Height (m)	Location	Lateral Siting
NB04/04	4+460	4+535	1.5	Proposed Road Development Mainline	Westbound side
NB04/05	0+185	0+225	2.5	Cappagh Road South of Cappagh Road Junction	Southbound side
NB04/06	0+140	0+185	2.5	Cappagh Road South of Cappagh Road Junction	Southbound side
NB05/01	5+525	5+615	3.5	Proposed Road Development Mainline	Westbound side
NB05/02	0+080	0+110	3.0	Ballymoneen Road south of Ballymoneen Road Junction	Northbound side
NB05/03	0+000	0+060	2.5	Ballymoneen Road south of Ballymoneen Road Junction	Northbound side
NB05/04	5+660	5+750	2.5	Proposed Road Development Mainline	Eastbound side
NB05/05	0+145	0+160	2.0	Ballymoneen Road north of Ballymoneen Road Junction	Southbound side
NB05/06	0+170	0+225	2.0	Ballymoneen Road north of Ballymoneen Road Junction	Southbound side
NB05/07	5+910	6+110	2.0	Proposed Road Development Mainline	Westbound side
NB06/01	6+400	6+555	2.0	Proposed Road Development Mainline	Eastbound side
NB06/02	6+870	7+100	2.0	Proposed Road Development Mainline	Westbound side
NB07/01	7+165	7+210	2.5	Proposed Road Development Mainline	Eastbound side
NB07/02	0+000 7+210	0+250 7+260	2.5	N59 Letteragh Junction EB diverge	Eastbound side
NB07/03	7+180	7+440	2.0	Proposed Road Development Mainline	Westbound side
NB07/04	1+415	1+470	2.0	N59 Link Road South	Southbound side
NB07/05	0+105	0+175	2.0	Letteragh Road L1323	Eastbound side
NB07/06	0+030	0+065	2.0	Letteragh Road L1323	Eastbound side
NB07/07	0+000	0+025	2.0	Letteragh Road L1323	Eastbound side
NB08/01	0+060 8+010	0+000 8+070	2.5	N59 Letteragh Junction WB diverge	Westbound side

Structure Name	Start Chainage	End Chainage	Height (m)	Location	Lateral Siting
NB08/02	8+070	8+280	2.5	Proposed Road Development Mainline	Westbound side
NB08/03	8+280	8+540	3.0	Proposed Road Development Mainline	Westbound side
NB08/04	8+100	8+230	3.5	Proposed Road Development Mainline	Eastbound side
NB08/05	8+230	8+375	4.0	Proposed Road Development Mainline	Eastbound side
NB08/06	8+375	8+405	3.5	Proposed Road Development Mainline	Eastbound side
NB08/07	8+545	8+850	2.5	Proposed Road Development Mainline	Eastbound side
NB08/08	8+850	9+500	2.0	Proposed Road Development Mainline	Eastbound side
NB08/09	8+540	8+760	2.5	Proposed Road Development Mainline	Westbound side
NB08/10	8+760	8+790	2.0	Proposed Road Development Mainline	Westbound side
NB08/11	8+850	9+500	2.0	Proposed Road Development Mainline	Westbound side
NB08/12	8+405	8+525	3.0	Proposed Road Development Mainline	Eastbound side
NB08/13	8+525	8+545	2.5	Proposed Road Development Mainline	Eastbound side
NB08/14	8+800	8+850	2.0	Proposed Road Development Mainline	Westbound side
NB09/01	9+990	10+100	1.5	Proposed Road Development Mainline	Eastbound side
NB10/01	10+420	10+780	3.0	Proposed Road Development Mainline	Westbound side
NB11/01	11+910	12+120	3.5	Proposed Road Development Mainline	Eastbound side
NB11/02	11+980	12+120	2.5	Proposed Road Development Mainline	Westbound side
NB12/01	12+140	12+350	3.0	Proposed Road Development Mainline	Eastbound side
NB12/02	0+180	0+350	2.0	N84 Headford Road Junction WB diverge	Westbound side
NB12/03	0+050	0+080	2.0	N84 Headford Road	Northbound side
NB12/04	0+090	0+150	2.0	N84 Headford Road	Northbound side
NB12/05	12+910	13+020	2.5	Proposed Road Development Mainline	Westbound side

Structure Name	Start Chainage	End Chainage	Height (m)	Location	Lateral Siting
NB12/06	12+870	13+050	3.5	Proposed Road Development Mainline	Eastbound side
NB12/07	12+140	12+350	2.5	Proposed Road Development Mainline	Westbound side
NB13/01	13+020	13+165	3.0	Proposed Road Development Mainline	Westbound side
NB13/02	13+050	13+120	3.0	Proposed Road Development Mainline	Eastbound side
NB13/03	13+160	13+370	2.0	Proposed Road Development Mainline	Eastbound side
NB13/04	13+360	13+640	3.0	Proposed Road Development Mainline	Westbound side
NB13/05	13+590	13+935	3.5	Proposed Road Development Mainline	Westbound side
NB13/06	0+240 13+640	0+000 13+840	3.0	N83 Tuam Road Junction WB merge	Westbound side
NB13/07	13+620	13+960	3.5	Proposed Road Development Mainline	Eastbound side
NB15/01	15+200	15+720	2.5	Proposed Road Development Mainline	Eastbound side

Where environmental barriers are not located on bridge structures, the barriers are to be of timber panel construction supported by steel posts.

At the River Corrib Bridge, S08/04, a 2m high transparent noise barrier with an appropriate level of aesthetic quality is to be provided as noted in **Section 7.3.1**.

8 Drainage, Hydrology & Flood Risk

8.1 Drainage General

The proposed N6 Galway City Ring Road scheme involves the construction of a new drainage system as well as an assessment of relevant existing drainage infrastructure including the upgrading or extension of existing culverts and sewers as deemed necessary as part of the scheme development.

This chapter of the report provides an overview of the type of drainage system to be used, the drainage design criteria and the methods employed.

The road drainage system shall be designed in accordance with Transport Infrastructure Ireland (TII) current design standards, TII publications and the Manual of Contract Documents for Road Works (MCRW).

An extract from DN-DNG-03066 (HA 33) - Design of Earthworks Drainage, Network Drainage, Attenuation & Pollution Control depicting the standards map is presented in **Figure 8.1** below. This shows the interaction between the various standards in the TII publication suite of documents

Figure 8.1: Standards Map

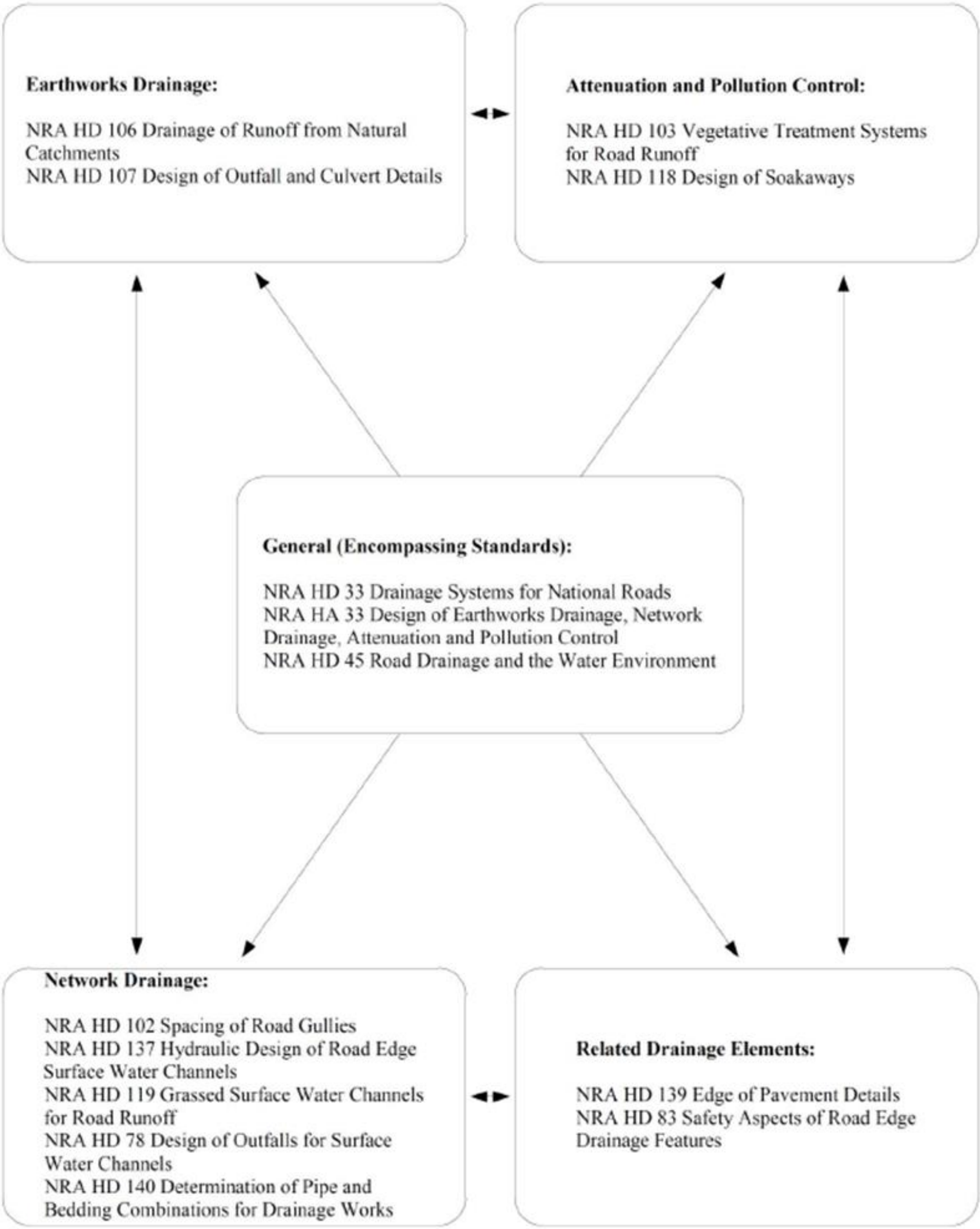


Figure 1/1 Standards Map

The Office of Public Works (OPW), the National Parks and Wildlife Service (NPWS), Irish Water, Galway City Council and the Inland Fisheries Ireland (IFI) have been consulted during the preliminary design phase of the proposed road development. Preliminary drainage drawings provide an overview of the proposed drainage concepts and treatments employed over the proposed road development. These drawings indicate the drainage infrastructure adopted in a particular location and the proposed outfall location from each drainage network. They also present the flow directions of pipes and ditches.

The location and preliminary sizing of flow control devices, pollution control measures, surface water attenuation storage and infiltration measures are also identified on the drawings. Refer to Drawings **GCOB-500-D-100** to **GCOB-500-D-132** in **Volume 2**.

Due to the contrasting geological features across the proposed road development extents the type of natural drainage can be split into two different broad categories to the west and to the 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, streams and rivers convey flow to the sea. The underlying bedrock is granite. In this area, there is a low importance, poor aquifer where the bedrock is generally unproductive except for local zones. 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 via infiltration, which results in the recharge to the underlying groundwater body. Extreme rainfall events accumulate 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. Except for the River Corrib, Terryland Stream, Ballindooley Lough and Coolagh Lakes there are no other significant watercourses in the area.

The two different categories of natural drainage informs 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 the road runoff 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 which are outlined in the sections below.

8.2 Existing Watercourses & Culverts

There are a number of existing streams and rivers that the N6 GCRR traverses along its route. The streams and rivers will be conveyed across the N6 GCRR using culverts and/or bridge structures. River and stream flows have been quantified by the scheme hydrologist and the crossings have been designed in accordance with the OPW requirements for crossing of streams and rivers and the requirements of TII publications documents: DN-DNG-03064 (HD 106) – Drainage of Runoff from Natural Catchments, DN-DNG-03071(HD 107) – Design of Outfall and Culvert Details and DN-DNG-03065 (HD 45) – Road Drainage and the Water Environment for minor watercourses. All required culverts have been designed so as to minimise impact on both upstream and downstream flood conditions.

Excluding the River Corrib there are a total of 16 stream culvert sites proposed, 15 culverts in the western section and 1 culvert 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 a catchment area of 5.5km^2.

The majority of these watercourses flow in a general southerly direction discharging to Galway Bay with watercourses east of the Bearna Stream discharging to the

Galway Bay Complex cSAC and watercourses west of the Bearna Stream discharging to Galway Bay outside of the Galway Bay Complex cSAC.

In addition to the hydraulic requirements for the road crossings, consideration has also been given for the passage of mammals at 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.

All of the proposed structures over existing watercourses have been submitted to the OPW under Section 50 of the Arterial Drainage Act, 1945. Details of required stream realignments in the vicinity of the structures have also been submitted. Consent of the Commissioners of Public Works under Section 50 of the Arterial Drainage Act, 1945 was given on 9 August 2017 and a copy of this consent is provided in **Appendix A.8.1**.

There are a small number of salmonid rivers interacting with the N6 GCRR. Inland Fisheries Ireland have been consulted regarding the requirements for fish passage at these locations.

8.2.1 Design Criteria

Table 8.1 below summarises the design criteria adopted by the Design Team in accordance with OPW requirements for construction of hydraulic culverts and bridges over watercourses.

Table 8.1: Design Criteria for Culverts and Bridges

Parameter	Criteria
Design Flow	1% AEP* 1 in 100-year Return Period
Climate Change Allowance	20% Increase in Flow to Cater for Climate Change
Minimum Culvert Size	Height Minimum of 900 mm
Embedment Depth	150mm for Circular Culverts 300mm for Rectangular Box Culverts
Freeboard	Minimum of 300mm above Design Flood Water Level

** AEP = Annual Exceedance Probability*

Hydrological calculations of design flows for culverts are estimated using statistical flood frequency analysis methods if watercourses are gauged and have a sufficiently long flow record.

If catchments are ungauged design flows will be estimated in accordance with the IH124 Method or the Flood Study Update (FSU) Method. The flood flows are factored by growth factors derived using the FSU pooling group method and multiplied by the factorial error relevant to the flood estimation method. The flows are further increased by 20% to cater for the effects of climate change. The resulting highest flow between the two estimation methods is selected as the design flow.

Further details for flood flow estimation are provided in the River Corrib Hydrology Report contained in **Appendix A.8.1** Hydrology Reports and Section 50 Approval.

All new culverts have been designed for a flood with a return period of 1 in 100 years with a minimum of 300mm freeboard between the design water level and the soffit level of the culvert in accordance with OPW requirements.

A minimum culvert diameter of 900mm is adopted on all new culverts conveying watercourses to ensure accessibility for future maintenance and reduce the likelihood of blockages in accordance with OPW requirements. The minimum culvert diameter for ditches and earthworks drainage cross-drains should be 450mm as smaller sizes are prone to blockage in accordance with TII publications and is discussed further in **Section 8.4** below.

In general, lengths of new culverts will be kept to a minimum to allow for maximum light penetration. In some instances, this will result in the watercourse being diverted. River/stream diversions are designed to maintain existing watercourse characteristics.

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.

Any existing culverts impacted by the proposed N6 GCRR development works will be assessed in relation to their existing capacity and structural stability. These culverts will be extended, up-graded or replaced as necessary. This will also apply to culverts impacted by side roads or access tracks. All new/replaced culverts shall be no less in dimension and capacity than the existing. Section 50 approval has also been sought in the case of upgraded or extended culverts.

Table 8.2 lists the proposed culverts in addition to their required size, length and embedment. The location of the proposed culverts are identified on Drawings **GCOB-500-D-500** to **GCOB-500-D-514** in **Volume 2**. Typical cross-section details for the hydraulic culverts are shown on Drawings **GCOB-500-D-515** to **GCOB-500-D-523** in **Volume 2**. Culverts or pipes with a clear span greater than 2.0m are classified as structures in accordance with the DN-STR-03001 (BD 2). Refer to **Chapter 7, Structures** for additional structural culvert details.

Table 8.2: Proposed Culvert Schedule

Culvert Reference	Chainage	Referenced Mainline / Side Road	Location X	Location Y	Culvert Diameter/ Width x Height	Approx. Length (m)
C00/01	672	Mainline	521324.58	723181.58	Box 2.5m by 1.35	94.4
C00/02	984	Mainline	521521.68	723446.01	1.2m diameter	46.1
C01/01	580	Side Road Troscaigh South	521983.64	723778.87	1.2m diameter	27.6
C02/01a	133	Side Road Bearna to Moycullen Road	523086.54	724283.58	Box 2.1m by 1.8m	36.66
C02/01b	2800	Mainline	523179.61	724198.04	Box 2.5m by 2.5m	68.2
C03/01	3067	Mainline	523354.16	724244.47	Box 2.5m by 1.2m	47.7
C03/02	48	Side Road Aille	523615.65	724390.32	0.9m diameter	15
C03/03 C03/04	3945	Mainline	524066.24 & 524079.03	724705.91 & 724722.20	Box 2.5m by 2.5m Box 2.5m by 2.5m	53.4 51.7
C04/01	3963	Mainline	524201.84	724845.74	Box 5m by 2.5	34.9
C04/02	4120	Mainline	524895.00	725274.42	Box 3.1m by 2.5	80.4
C06/01	6850	Mainline	526420.87	726389.37	Box 2.5m by 2.5m	64.8
C07/02B	75	Side Road Letteragh	526710.48	726684.02	1.2m diameter	14
C07/02A	7225	Mainline	526698.49	726637.16	Box 2.5m by 2.5m	82.1
C08/01	8390	Mainline	527683.34	727251.88	1.2m diameter	82.5
C10/02	10735	Mainline	529687.79	728412.26	1.2m diameter	41.8
C07/01a	1617	Side Road N59 Link Road	527147.52	726262.40	1.2m diameter	37.2

8.3 Hydrogeology

8.3.1 Background

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 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 Burren Formation, which underlies the eastern section of the proposed road development from the N59 Moycullen Road to existing N6 at Coolagh

Under the Water Framework Directive the GSI have delineated a number of groundwater bodies (GWB) in the western section. These are based on surface topography and watersheds and are:

- Spiddal GWB
- Maam-Clonbur GWB

The GSI have delineated six GWB in eastern section, which are subdivided based on topography and surface water catchments. The GWB include:

- Ross Lake
- GWDTE Lough Corrib Fen 1 (Menlough)
- GWDTE Lough Corrib Fen 2
- GWDTE Lough Corrib Fen 3 & 4
- Clare-Corrib
- Clarinbridge

8.3.2 Groundwater Protection Response (GPR)

In accordance with the requirements and policies set out by the European Communities Environmental Objectives (Groundwater) Regulations 2010 and the Water Framework Directive (WFD) 200/60/EC for Ireland, groundwater bodies must be protected. As there is potential for road runoff to discharge to groundwater bodies via permeable drainage systems and for the runoff to be contaminated, a methodology is set out as part of TII publications document DN-DNG-03065 (HD 45) Road Drainage and the Water Environment, to assess the groundwater protection response (GPR) for the use of permeable drainage systems on road schemes. The GPR is a preliminary screening tool developed to assess the potential risk to groundwater quality from routine runoff from roads. The methodology employed for the assessment is Method C. This assessment is documented in **Appendix A.8.2** – HD45 Groundwater Protection Response Assessment.

For the drainage networks located to the west of the N59 Moycullen Road located on the Galway Granite Batholite the GPR indicates that the use of permeable drainage systems are generally acceptable subject to the minimum design standards for permeable drains outlined in the TII publications and the following additional minimum requirements as outlined in the protection response matrix DN-DNG-03065 Table A.4

- There is a consistent minimum thickness of 1m unsaturated subsoil, or 2m in areas of karstified rock (Rk & Lk), beneath the invert level of the drainage system
- During all stages of design particular attention must be paid to the presence of karst features and additional assessments undertaken if required. If karst features are identified response R2 (3) must be applied as a minimum
- During all stages of design particular attention must be paid to receptors (such as; public wells, group schemes, industrial water supply sources and springs) and additional assessments undertaken if required

For the drainage networks located to the east of the River Corrib located on the Visean Undifferentiated Limestone, the GPR indicates that use of permeable drains is not generally acceptable. However, due to the lack of surface watercourses or public sewers in some locations, and hence suitable surface water drainage outfall locations, infiltration basins are proposed. Detailed hydrogeological assessments for each infiltration basin have been carried out and a number of pollution control design measures are required to be put in place on the upstream drainage network. For the full extent of the networks over the Visean Undifferentiated Limestone a sealed network drainage system is required to deliver all runoff to a controlled treatment and infiltration area.

8.3.3 Evaluation of Groundwater Impacts

The hydrogeological impacts have been assessed as part of the EIA Report and are outlined fully in Chapter 10 of the EIA Report A summary of the main assessments carried out to assess the potential risk to groundwater is presented below:

- Dewatering (construction and operation) will be required within cuttings in the Galway Granite Batholith. Any intercepted groundwater will be collected and piped to the surface water receptor it would naturally have drained to
- Dewatering of the bedrock aquifer (construction or operation) will not be undertaken in the Lough Corrib Fen 1 (Menlough) GWB or in the adjacent Clare-Corrib GWB within 500m of the GWB divide. This area of the proposed road development includes Menlough Viaduct and Lackagh Tunnel (including its approaches)
- Dewatering (construction and operation) will be required in cutting at Ch. 13+050 to Ch. 13+650 (EW27) during peak groundwater levels. Any dewatering will be discharged to the same GWB. 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

- Dewatering (construction only) will be required at the Galway Racecourse Tunnel (and its approaches). All groundwater intercepted will be managed and discharged within the same GWB
- Infiltration from construction runoff on the Galway Granite Batholith will be small (<10%) and have no impact on groundwater quality. Runoff from the Galway Granite Batholith is discharged of to surface water courses
- Infiltration from construction runoff on the Visean Undifferentiated Limestone will occur both on the construction footprint and from infiltration basins. There is the potential for impact to groundwater quality if karst is encountered. Hydrogeological mitigation measures are required to control runoff and ensure that infiltration both on the footprint and within infiltration basins is prevented from point inputs to karst
- Accidental spills during construction have the potential to impact on groundwater and are dealt with in mitigation
- 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 site footprint
- The Drainage design of the proposed road development in the Undifferentiated Visean Limestone has sealed drainage and uses infiltration basins (operational phases) to discharge of treated runoff

The design assessment has identified a risk specific to areas karst in the Visean Undifferentiated Limestone. There is potential for karst in GWDTE Lough Corrib Fen 1 (Menlough) 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 quality. Certain mitigation measures are proposed for the construction and operational phase and are detailed in the EIA Report. In the event of karst being encountered the Karst Protocol, which is documented in the Construction Environmental Management Plan (CEMP) shall be followed.

8.4 Pre-Earthworks Drainage

Interceptor ditches will be located so as to fully intercept the overland flow from the natural catchments adjacent to the proposed road development, both during construction and the operational phases. The ditches have been sized to cater for a 1 in 75-year return period as per DN-DNG-03064 (HD 106) Drainage of Runoff from Natural Catchments.

The interceptor ditches will be required to collect surface water runoff at the top of the cuttings or the base of the embankments where the adjacent land falls towards the proposed road development. Refer to Drawings **GCOB-500-D-100** to **GCOB-500-D-132** in **Volume 2** for the location of these drains. The interceptor ditches will prevent surface water from adjacent lands from flowing onto the proposed works, and prevent ponding of water at the toe of embankments. Any land drains that are interrupted by the new works will be diverted or discharged into an interceptor ditch.

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 proposed route of the proposed road development, some of the interception ditches are considerably deep so as to achieve suitable outfalls for the pre-earthworks drainage (PED). To the east of the River Corrib, interceptor ditches will discharge to suitably sized infiltration trenches located adjacent to the proposed road development. In general, these are located adjacent to the proposed earthworks. Cross-drains will be provided to convey flow from the interceptor ditches beneath the proposed road development to the outfall/discharge locations where required.

The extent of the earthworks and provision of infiltration trenches for discharge of pre-earthworks drainage has been assessed and taken into consideration when setting the fenceline and extents of the land required for the N6 GCRR.

8.4.1 Design Criteria

The following specific design criteria for the interceptor ditches and associated cross-drains have been adopted by the Design Team in accordance with the TII Publications and a summary is provided in **Table 8.3** below.

- Hydrological calculations for natural catchment cross-drains will be estimated in accordance with the IH124 Method and the Agricultural Development and Advisory Service (ADAS) Method, depending on the size of the catchment and in accordance with DN-DNG-03064 (HD 106) - Drainage of Runoff from Natural Catchments
- For rural catchments area of up to 0.4km^2 ADAS method is employed. For catchments larger than 0.4km^2 the IH124 method is utilised
- Flows will be increased by 20% to cater for the effects of climate change in accordance with DN-DNG03022 (HD33) - Drainage Systems for National Roads
- In accordance with the guidance of DN-DNG-03064 (HD106)- Drainage of Runoff from Natural Catchments flow rates from natural catchments without defined watercourses will be assessed for design storms with a return period of 75 years
- Cross-drains conveying interceptor ditch flow shall be no less than 450mm in diameter
- Where cross-drains are for existing land drains they shall, as a minimum, be of similar width to that of the existing water channel, be similar to the gradient of the existing land drain and shall not significantly increase the flow of the existing watercourse by their inclusion

Table 8.3: Interceptor Ditch & Interceptor Cross-Drain Design Criteria

Parameter	Criteria
Flood Estimation Method	Catchment Area < 0.4km^2 – ADAS Estimation Method Catchment Area > 0.4km^2 – IH124 Estimation Method
Return Period (year)	75
Climate Change	20% increase on flows
Min. Diameter Cross-Drain	450mm
Max. Channel Velocity	2.5m/s

Based on the above design criteria, two ditch types have been specified for the preliminary design of interceptor ditches along the route of the N6 GCRR. **Table 8.4** below summarises the ditch descriptors for both types. The interceptor ditches have been designed to ensure that where possible that velocities do not exceed 2.5m/s. In the case of channel velocities exceeding 2.5m/s scour protection shall be provided.

Table 8.4: Interceptor Ditch Descriptor

Ditch Type	Type 1	Type 2
Base Width (m)	0.6	1.0
Side Slope (1:X)	1	1
Ditch Depth (m)	0.6	0.6
Freeboard Included (m)	0.3	0.3
Minimum Longitudinal Gradient (1:X)	500	500
Manning’s ‘n’ Roughness	0.05	0.05

To the east of the River Corrib, in the absence of watercourses, the pre-earthworks interceptor ditches will discharge direct to ground via stone filled infiltration trenches to mimic the existing recharge of groundwater. The design of infiltration trenches has been carried out in accordance with BRE Digest 365 Soakaway Design. Infiltration trenches have been designed to cater for runoff in the interceptor ditches (Q75 year return period flow) event occurring for 1 hour. A summary of the infiltration trench sizes are presented Table 8.5 below. Detailed calculations are provided in **Appendix A.8.3** – Pre-Earthworks Drainage Schedule.

Table 8.5: Infiltration Trench Details

Infiltration Trench Reference	Size		
	Width (m)	Depth (m)	Length (m)
INF-E-N-003	4	1.5	20
INF-E-N-005	2	1.5	6.5
INF-E-N-006	4	2	57
INF-E-N-006A	2.8	1.5	20
INF-E-N-010	7.6	2	40

Infiltration Trench Reference	Size		
INF-E-N-011	3.7	1.5	20
INF-E-N-013	3	1.5	32
INF-E-N-014	2	1.5	7
INF-E-N-015	5	2	37
INF-E-N-016	3.8	1.5	20
INF-E-N-018B	4	1.5	20
INF-E-N-019	6.5	1.5	20
INF-E-N-020	7	1.5	25
INF-E-N-021	2	1.5	5
INF-E-N-022	4.5	1.5	20
INF-E-N-023	5.5	1.5	20
INF-E-N-024	10	2.2	30
INF-E-N-025	2	1.5	18
INF-E-N-026	2	1.5	5.5
INF-E-S-001	2	1	4
INF-E-S-004	10	1.5	30
INF-E-S-005	5	1.5	20
INF-E-S-007	5	1.5	49
INF-E-S-008	2	1.5	6.5
INF-E-S-012	8.5	2	30
INF-E-S-013	2.5	1.5	15
INF-E-S-015	7	1.5	34
INF-E-S-017a	2.5	1.5	20
INF-E-S-018	2	1.5	17
INF-E-S-018a	2	1.5	17
INF-E-S-019	5.8	1.5	20
INF-E-S-020	3	1.5	20
INF-E-S-021	6	1.5	25
INF-E-S-023	2	1.5	30

Cross-drains are required where interceptor ditches and/or existing land drains are required to cross the proposed road development to maintain the existing flow paths of the surrounding surface water drainage. A summary of the primary interceptor ditch crossings of the mainline, link roads and sides roads is provided in **Table 8.6** below. In addition to the cross-drains outlined in **Table 8.6** below, cross-drains may be required for crossing of individual private land access from access tracks.

Table 8.6: Cross-Drain Details – Pre-Earthworks Drainage

Cross-Drain Reference	Approx. Chainage	Referenced Mainline / Side road	Cross-Drain Diameter (mm)	Minimum Gradient (1:X)	Approx. Length (m)
CD-00-00	0	Side road - R336	525	455	22
CD-01-00	1100	Mainline	450	385	40
CD-01-01	1150	Side road - New Foraí Maola / Troscaigh Link Road	450	385	34
CD-01-02	1380	Side road - New Foraí Maola / Troscaigh Link Rd	450	385	16
CD-01-03	1560	Mainline	450	385	32
CD-01-04	1280	Side road - New Foraí Maola / Troscaigh Link Rd	450	385	37.8
CD-01-05	1300	Side road - New Foraí Maola / Troscaigh Link Rd	450	385	35.9
CD-01-06	1750	Accomodation Road	450	385	13.0
CD-02-00	2800	Side road - Bearna to Moycullen Rd	450	385	25
CD-03-00	3350	Side road - Aille Road	450	385	25
CD-04-00	4450	Side road - Cappagh Road	525	455	20
CD-04-01	4490	Mainline	450	385	25
CD-06-00	6325	Mainline	450	385	68
CD-06-01	6343	Mainline	450	385	95
CD-06-02	6335	Side road - Rahoon Road	450	385	13
CD-06-03	6450	Side road - Clybaun Road	450	385	23
CD-06-04	6475	Mainline	450	385	64
CD-06-05	6700	Mainline	450	385	35
CD-07-00	7550	Side road - New South N59 Link Road	450	385	32
CD-07-01	7000	Side road - New South N59 Link Road	450	385	22

Cross-Drain Reference	Approx. Chainage	Referenced Mainline / Side road	Cross-Drain Diameter (mm)	Minimum Gradient (1:X)	Approx. Length (m)
CD-07-02	7000	Side road - New South N59 Link Road	450	385	23
CD-07-03	7000	Side road - New South N59 Link Road	450	385	25
CD-07-04	7000	Side road - New South N59 Link Road	450	385	15
CD-07-05	7430	Mainline	450	385	13.5
CD-07-06	7550	Side road - New North N59 Link Road	450	385	13
CD-07-07	7500	Side road - New South N59 Link Road	450	385	75
CD-07-08	7500	Side road - New South N59 Link Road	450	385	10
CD-08-00	8400	Side road - New North N59 Link Road	450	385	26
CD-08-01	8401	Side road - New North N59 Link Road	450	385	25
CD-08-02	8250	Mainline	525	455	145
CD-09-00	9400	Mainline	450	385	105
CD-10-00	10620	Mainline	450	385	15
CD-10-01	1720	Mainline	450	385	126
CD-10-02	10840	Mainline	450	385	12
CD-10-03	10860	Mainline	450	385	4
CD-10-04	10920	Mainline	450	385	12
CD-11-00	11000	Mainline	450	385	8
CD-12-00	12010	Mainline	450	385	11
CD-12-01	12300	Mainline	450	385	39
CD-13-00	13650	Side road - N83 Tuam Road	450	385	5
CD-13-01	13750	Side road - N83 Tuam Road	450	385	13
CD-14-00	14100	Side road - Parkmore Link Road	450	385	20

Cross-Drain Reference	Approx. Chainage	Referenced Mainline / Side road	Cross-Drain Diameter (mm)	Minimum Gradient (1:X)	Approx. Length (m)
CD-14-01	14100	Side road - Parkmore Link Road	450	385	13

8.5 Carriageway Network Drainage

A drainage system for the proposed road development has been designed such that surface water drainage and sub-grade drainage will be provided for the mainline carriageway, link roads and all new sections of local and regional roads. A summary of the main design requirements from TII publications drainage design documents are listed below in **Table 8.7**. The drainage schedule contained in **Appendix A.8.5** provides details for the proposed carriageway drainage network.

Table 8.7: Network Drainage Design Requirements

Drainage Element	Design Requirement	Reference TII Publication
Longitudinal Drains	1 in 1-year in-bore without surcharge 1 in 5-year without flooding	HD33 Para. 6.2
Transverse Drains including gully connections crossing beneath the carriageway	1 in 50-years in bore without surcharge or a minimum of 300mm	HD33 Para. 6.2
Combined Surface Water and ground water drains	1 in 1-year in bore without surcharge 1 in 5-year causing no surcharge above the formation/sub formation where capping is present	HD33 Para. 6.2
Surface Water Channels	1 in 1-year contained within the channel & check 1 in 5-year against allowable surcharge width	HD33 Para. 6.3
Allowable surcharge width at edge of pavement during a 1 in 5-year storm	(Hard shoulder Width – 0.5m) = (2.5-0.5) = 2.0 metres Or 0.5m on roads with no hardstrip or hardstrips < 1m	HD33 Para. 2.8
Climate Change	20% increase on rainfall intensities	HD33 Para. 6.3
Peak Flow Rates	“No worsening” in peak flow rates at the scheme boundary up to the 1 in 100-year return period storm event	HD33 Para 7.5
Runoff Attenuation	1 in 100-year without surcharge	HD33 Para 7.5
Minimum Pipe Diameters	225mm (Except Gully Connector permitted at 150mm)	HD33 Para 6.21

Drainage Element	Design Requirement	Reference TII Publication
Pipe Diameters Combined Filter Drains	Minimum: 225mm Maximum: 450mm	
Minimum Pipe Velocity	0.75m/s	HD33 Para 6.21
Maximum Discharge Velocity	2.5m/s at 1 in 1-year	HD33 Para 6.21
Maximum Manhole / Catchpit Spacing	100 metres	HD33 Para 6.8
Minimum cover for drainage structures	1.2m without protective measures	
Pipe Roughness	Carrier Drains 0.6mm Foul Sewers 1.5mm Filter Drains 1.5mm	HA 33
Runoff Coefficients	Paved: 1.0 Embankments: 0.5 Verges and grassed median: 0.5	
Manning's "n" for roads	0.017	HD 102 Para. 4.3
Manning's "n" for boundary drains	0.05	HD 106 C.2

A full hydrogeological assessment of the underlying groundwater bodies has been carried out and is detailed above in **Section 8.3**. Following the results of this assessment the issue of groundwater drainage problems can be assessed further.

8.5.1 N6 GCRR Western Section (West of N59 Moycullen Road)

In the western section of the scheme from the R336 Coast Road to the N59 Moycullen Road, there are no site specific conditions (e.g. sensitive groundwater bodies) on the mainline alignment that require a kerbed drainage system except on approach to junctions where pedestrian crossing facilities are provided. The proposed verge side drainage network is in accordance with Figure 3.1 of DN-DNG-03022 (HD33) Drainage Systems for National Roads. For cuttings and low embankments a separate filter drain or narrow filter drain will be provided to intercept sub-surface flows.

8.5.2 N6 GCRR Eastern Section (East of Moycullen Road)

However, in the eastern section of the scheme from the N59 Moycullen Road to the tie-in with the existing N6 at Coolagh, 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. This is required to protect the aquifer following the groundwater risk assessment carried out in accordance with DN-DNG-03065 - (HD45) Road Drainage and the Water

Environment. Refer to **Appendix A.8.2** for further details. Therefore, the network picking up the drainage from the carriageway will be kept separate to the groundwater and sub-surface drainage network. This can be achieved by using either a kerb, gully and sealed carrier pipe system or a surface water channel (SWC) (generally concrete) and sealed 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 or narrow filter drain will be provided to intercept sub-surface flows.

Suitably sized and located outfalls will be designed in accordance with DN-DNG-03071 (HD 107) - Design of Outfall and Culvert Details.

8.5.3 Roads on Embankments

In the western section of the proposed road development, the design has followed the approach as outlined in Figure 3.1 of DN-DNG-03022 - (HD33) Drainage Systems for National Roads. For embankments less than 1.5m in height, a combined filter drain or grassed surface water channel (GSWC) and carrier system is utilised.

The size of combined filter drain will be limited to between 225mm and 450mm and will discharge to a sealed carrier drain once the capacity of the 450mm has been reached. Measures shall be taken in the execution and completion of the works to avoid stone scatter in accordance with measures outlined in DN-DNG-03022 - (HD33) Drainage Systems for National Roads, especially on the approach to junctions where the hard shoulder width reduces to less than 2.5m. Typical measures may include spraying the top surface of exposed filter material with bitumen, use of bitumen bonded filter material in the top 200mm of the trench or the use of geogrids to reinforce the surface layer of the filter material.

On the eastern section of the proposed road development, due to the presence of karst and vulnerable aquifers, the use of over the edge drains, grassed surface water channels and combined filter drains are precluded. Therefore all embankments will be drained using a SWC and sealed carrier system.

8.5.4 Roads in Cutting

In the western section of the proposed road development, the preferred solution for drainage of the road in cuttings is a grassed surface water channel and carrier drain system in areas where groundwater is not within 300mm of the formation/sub formation layer. The GSWC offers an element of treatment of water quality to the runoff from the carriageway. However, in areas of large cuttings or where the groundwater level is within 300mm of the formation/sub-formation level the preferred drainage solution in the design is to utilise a SWC with a sealed carrier pipe and separate filter drain. This is to remove the possibility of groundwater discharging to the treatment wetlands and attenuation facilities.

Where groundwater vulnerability is high, for example in cuttings in karst areas in the eastern section of the proposed road development, a closed drainage system such as a SWC with sealed carrier pipe with a fin/narrow filter drain will be adopted. This permits free drainage of the cuttings and road surface without allowing the run off to percolate into the groundwater, thus eliminating a potential pollution hazard.

There are areas in the vicinity of the tunnel portals, where dewatering of the cuttings is not permitted. This is due to the sensitivity of the underlying aquifer and cSAC at the western approach to Lackagh Tunnel. At the eastern approach to the Galway Racecourse Tunnel dewatering of the cutting is not proposed due to the extent of drawdown of the water table that would be required in the operational phase (dewatering is permitted during construction at this location) and the lack of suitable outfall location for same. At both of these locations it is proposed to seal the road to above the highest predicted groundwater level plus freeboard for the operational phases.

There are two locations along the mainline alignment where a low point occurs in a cutting. The chainages of these locations are Ch. 10+860 and Ch. 15+225. The low points at these locations are unavoidable as they both occur on the approach to the tunnel portals which require significant depth to achieve appropriate cover depth above the soffit of the tunnel structures.

The depth of cutting at the low point at Ch. 10+860 is approximately 7.6m and the depth of the cutting at the low point at Ch. 15+225 is 7.7m.

A number of design measures have been incorporated into the design to add resilience to the drainage network in the case of rainfall exceedance of the design event or accidental blockages.

At location Ch. 10+860 an emergency overland flow route at the back of the verge is provided via a V ditch, which will direct floodwaters away from the low point, along the southern verge and into the adjoining pre earthworks drain (PED) which discharges to the existing low point in the topography. This existing topography drains in a southern direction and will remove excess surface waters away from the cutting proposed road development.

At Ch. 15+225, there is no overland flow route away from the low point in the cutting. The following design measures have been incorporated into the design of the drainage servicing this low point.

An increased level of service is provided to the pipes in the S30 drainage catchment from the low point to its discharge point. The design return period for this location has been increased to the 1 in 1000-year return period storm event. This ensures that no flooding of the drainage network occurs in the local road catchment of the low point up to this return period event, therefore reducing the risk of flooding of the network in high intensity rainfall events. To achieve this, upsizing of the proposed surface water drain pipe sizes in this location is required. The design measure has two-fold benefits in that it adds additional capacity to the surface water network facilitating more efficient removal of surface waters from the area and it also reduces the risk of blockage significantly through the use of larger pipe diameters. A large pipe will pick up surface waters at Ch. 15+225 and convey water to the attenuation facility located adjacent to the proposed signalised Coolagh Junction.

Additional resilience shall be added during the detailed design of inlet structures from the linear drainage channels and median slot drains into the main drainage network. This can be achieved by increasing the frequency of inlet gullies from the linear drainage channels and increasing the size of the outlet pipes from the inspection chambers to the mainline. By providing additional infrastructure, this mitigates against the risk of blockage as it is less likely that all inlets to the pipe network would become blocked at the same time.

Herringbone drains will be provided to stabilize cut slopes in all areas where necessary.

8.5.5 Central Reserve

Along the length of the dual carriageway cross-section from Ballymoneen Road to the connection with the existing N6 at Coolagh, the central reserve contains a solid median barrier. In the case of normal cross fall, no drainage is proposed adjacent to the barrier. However, in the case of superelevated carriageways an insitu linear drainage system or gullies/surface water channel with carrier drain will be provided as per Figure 3.2 of the DN-DNG-03022 - (HD33) Drainage Systems for National Roads. This will be accompanied with a narrow filter drain where required and will be located on the low side of the carriageway falling towards the concrete barrier.

8.5.6 Tunnel Drainage

A separate isolated sealed drainage system will be utilised for the Lackagh Tunnel and Galway Racecourse Tunnel. The drainage systems are designed in accordance with DN-STR-03015 BD78 – Design of Road Tunnel. For both tunnel structures a sealed system of slot drains and carrier pipes will be used to pick up groundwater ingress, surface water from wheels, fire flows and tunnel wash down from the carriageway edge. The slot drains will be drained via carrier pipes to drainage sumps and pumped to the closest foul sewer. The location for the discharge points for each tunnel has been agreed with Irish Water using their Pre-Connection Enquiry application.

The location of the outfalls from the pumped tunnel drains to the public foul sewers are as outlined in **Table 8.8** below.

Table 8.8: Tunnel Outfall Details

Tunnel Reference	Location of Outfall	Public Foul Sewer Size	Agreed Pumped Discharge Rate
Lackagh Tunnel	Entrance to Crestwood Residential Estate	225 mm	5.9 l/s
Racecourse Tunnel	Racecourse Avenue	375 mm	5.9 l/s

This mitigates against the potential for pollution of groundwater and also minimises the risk to the cSAC surface water bodies. Pre-Connection Enquiries have been submitted to Irish Water and approval has been obtained for discharge of tunnel water to the public foul sewers. The pre-connection enquiry feedback obtained from Irish Water is contained in **Appendix A.8.7**.

8.5.6.1 Pump Station for Tunnels

Both pumping station installations shall include the following elements:

- Proprietary package pumping station including duty and standby pump
- Rising main
- Break head manhole chamber
- Storage tank
- Control kiosk
- By-pass spillage containment sump (25m3) for accidental spillages of hydrocarbons/chemicals

Table 8.9 indicates the key design criteria for the tunnel pump stations. Detailed calculations for pumping station are provided in **Appendix A.8.4**.

Table 8.9: Proprietary Pumping Station & Rising Main Design Requirements

Pump Station	**Lackagh Tunnel**	**Racecourse Tunnel**
Rising Main Size (mm)	100	100
Rising Main Length (m)	1683	20
Rising Main Minimum Velocity (m/s)	0.75	0.75
Pumping Rate (l/s)	5.9	5.9
Sump Invert Level (m AOD)	9.500	38.465
Static Head (m)	21.9	12.335
Discharge Level at Standoff Manhole (m AOD)	20.363	50.800

8.5.7 Viaducts & Bridge Structures

Drainage of the proposed bridge structures will be managed so as to achieve the requirements set out in DN-DNG003022 – (HD33) Drainage Systems for National Roads regarding return periods. 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 sealed carrier drains, before descending into the ground at suitable pier locations.

The sealed drainage system is required due to the sensitivity of the environment these structures are spanning. This is the River Corrib within the Lough Corrib cSAC beneath the River Corrib Bridge, and the Limestone Pavement and Turlough (Priority Annex 1 Habitat) beneath the Menlough Viaduct respectively. The drainage networks then discharge to a treatment wetland prior to outfalling to infiltration basins or the River Corrib.

8.5.8 Side Roads and Link Roads

Side roads consist of regional, local and minor access roads. Some of the side roads have footpaths and also may require kerbs at locations such as at bridge or junction locations. In these situations, the road will therefore be drained using gullies with carrier drains and a separate filter drain in areas where groundwater drainage problems exist e.g. large cuttings. Piped drains will discharge to an outfall, sealed drain, mainline drainage system or directly to the public storm sewer.

Side roads that do not require kerbs will be drained using either over-the-edge drainage or combined filter drains where appropriate. The filter drains will discharge to an outfall, sealed drain, existing field ditch, mainline drainage system or directly to the public sewer.

It has been agreed with Galway City Council that on side roads where overlays or minor upgrade works are required for the proposed road development the existing scenario is to be replicated. This is adopted where there are no dramatic increases in the paved area. The new drainage networks discharge to existing drainage systems (e.g. land drains or public storm sewers), without additional attenuation measures being provided, replicating the existing scenario. Further details of connections to the public surface water sewer network and capacity checks downstream of the outfall locations are provided in Section 8.6.

All proposed new link roads (Troscaigh/Na Foraí Maola Overbridge, N59 Link Road, City North Business Park Link Road and Parkmore Link Road) are provided with attenuation facilities to ensure that there is no worsening of peak flow rates at the site boundaries up to the 1 in 100-year flood event in accordance with DN-DNG-03022 – (HD33) Drainage Systems for National Roads.

8.6 Outfalls, Attenuation / Infiltration and Pollution Control Measures

The following section details the peak flow restriction to the road runoff rates proposed at outfalls to surface watercourses and associated attenuation storage in attenuation detention ponds. It also deals with discharges of road runoff to ground via infiltration basins. The design measures associated with pollution control are also discussed in this section.

8.6.1 Outfalls & Attenuation / Infiltration

Attenuation ponds will be provided at all major surface water outfalls along the length of the road scheme where sufficient land is available and are designed in accordance with DN-DNG-03063 – (HD 103) Vegetated Drainage Systems for Road Runoff. Additionally, where discharge is to ground via infiltration, infiltration basins are provided as the outfall. Where available land is severely restricted, over-sized pipes or swales may be provided to attenuate the carriageway discharge but this will only be considered where no other option is feasible. In the proposed road development, oversized pipes are only proposed in local roads and side roads. There are no oversized pipe attenuation facilities along the mainline.

For the two mainline drainage networks discharging directly to the River Corrib, S18A and S18B, no attenuation is provided as land disturbance in this area is especially sensitive due to the cSAC. As the flow capacity of the River Corrib is very large, an unattenuated discharge rate from these two adjacent catchments does not impact on the peak 1 in 100-year flow in the river. A departure from standard application was submitted to TII for the two networks outlined above and approval has been granted. **Table 8.10** gives details of the departures associated with the drainage design. Refer to **Appendix A.3.1** for a list of approved departures from TII departures from standards web portal.

Table 8.10: List of Drainage Departures

Departure Ref.	Location	Design Speed	Departure Element	Start Ch.	End Ch.	TII Reference
GCOB-DEP-DRA-001	Mainline Drainage Networks S18A and S18B Discharging to River Corrib	100 km/h	Runoff restriction and Attenuation Storage	8+600	10+150	11406

Surface water discharge from attenuation facilities will be released at a rate so as not to increase flooding downstream of any discharge point up to the 1 in 100-year return period storm event. Discharge will be provided from the attenuation measures at the green-field runoff rate.

Attenuation ponds are designed to cater for storm water storage up to and including the 1 in 100-year return period storm event with an 20% increase in flows to cater for the effects of climate change. An additional 300mm freeboard is included at all attenuation facilities. An overflow discharge facility will be provided for storms in excess of the freeboard. Where attenuation ponds are located in areas liable to flooding, e.g. river floodplains, ponds will be designed for a 1 in 100-year return period and an assessment of the impact of the pond on the hydraulic regime of the watercourse shall be undertaken and the pond bunded to a level 500mm above the adjacent 1 in 100 year flood level.

A total of 36 major outfalls across the mainline and link road drainage networks have been identified all of which require attenuation measures prior to being discharged to either an existing watercourse, an existing stormwater sewer or to ground via an infiltration pond.

Table 8.11 and **Table 8.12** summarise all outfalls where discharge is to surface water and where attenuation ponds will be required and **Table 8.13** summarises where discharge is to ground and infiltration ponds are required as part of the scheme.

There are numerous smaller drainage networks associated with the proposed road development and its side roads which utilise the existing road drainage systems. Where possible oversized pipes, ponds and tanks have been included in the design to provide attenuation. A summary of the attenuation measures, if provided are shown in **Table 8.14**.

Table 8.11: Proposed Mainline and Link Road Drainage Networks Discharging to Surface Watercourses

Drainage Network Ref. No.	Total Catchment Drainage Area (ha)	Greenfield Runoff Rate (Qbar) Or 5l/s whichever is greater (l/s)	Pavement Area (ha)	Attenuation Pond - Volume of Storage (m3)	Network Discharge Q100 (l/s)	Invert Level of Attention Pond (mAOD)	Attenuation Pond: Sealed or Non-Sealed
S1	2.047	7.35	1.285	894	8.4	6.44	Non-Sealed
S2	0.554	5.00	0.38	184	5.0	31.50	Non-Sealed
S3	2.309	8.29	1.281	1028	8.7	37.18	Non-Sealed
S4A	0.963	5.00	0.624	324	5.2	48.80	Non-Sealed
S5A	2.451	8.80	1.532	977	9.7	40.73	Non-Sealed
S7A	0.304	5.00	0.244	81	4.8	36.85	Non-Sealed
S7B	2.939	10.56	1.07	1081	11.5	19.06	Non-Sealed
S8	0.424	5.00	0.256	114	4.7	19.95	Non-Sealed
S9	1.746	6.27	1.192	796	8.2	22.29	Non-Sealed
S10	2.188	7.86	1.219	873	8.3	44.50	Non-Sealed
S12	3.152	11.32	2.446	1697	11.5	53.65	Non-Sealed
S13	0.906	5.00	0.632	378	5.0	60.04	Non-Sealed
S14A	5.660	20.33	2.199	1975	21.0	35.00	Non-Sealed
S14B	0.849	5.00	0.652	613	5.2	22.11	Sealed
S18A	5.118	N/A	1.58	N/A	427.7	N/A	N/A
S18B	5.473	N/A	1.954	N/A	494.8	N/A	N/A
S21A	3.307	5.00	1.357	1568	5.200	13.75	Sealed
S4B	0.116	5.00	0.069	21	4.2	45.86	Non-Sealed
S15	1.893	6.80	0.727	692	7.5	6.68	Sealed

Table 8.12: Proposed Mainline & Link Road Drainage Networks Discharging to Surface Water Sewers

Drainage Network Ref. No.	Total Catchment Drainage Area (ha)	Greenfield Runoff Rate (Qbar) or Design Discharge (l/s)	Pavement Area (ha)	Attenuation Pond - Volume of Storage (m3)	Network Discharge Q100 (l/s)	Invert Level of Attention Pond (mAOD)	Attenuation Pond: Sealed or Non-Sealed
S11	2.024	7.27	1.572	1127	7.8	54.00	Non-Sealed
S26	5.118	4.10	3.472	3265	4.5	28.83	Sealed
S29	2.730	5.00	2.074	1740	5.0	28.15	Sealed
S30	6.332	5.05	4.58	4227	5.7	33.45	Sealed
S16A	4.158	14.93	2.149	1620	16.1	36.64	Non-Sealed
S17A	1.077	5.00	0.982	522	5.7	30.09	Non-Sealed
S22C1	1.457	5.00	1.361	786	5.0	24.09	Sealed

Infiltration Basins are designed to cater for storm water storage up to and including the 1 in 100-year return period storm event with a 20% increase in flows to cater for the effects of climate change. An additional 300mm freeboard is included at all infiltration facilities. An overflow discharge facility will be provided for storms in excess of the freeboard. Ground investigation works at the proposed locations of the infiltration basins have been undertaken to mitigate risk to the design by informing the permeability of the existing soil and bedrock. 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. A summary of the infiltration basins is provided in **Table 8.13**.

Table 8.13: Proposed Mainline and Link Rd Drainage Networks Discharging to Ground via Infiltration Basins

Drainage Network Ref. No.	Total Catchment Drainage Area (ha)	Infiltration Rate (l/s)	Infiltration Basin - Volume of Storage Q100 (m3)	Invert Level of Infiltration Basin (mAOD)
S19A	1.949	$1x10^{-5}$	1226	11.151
S19B	2.222	$1x10^{-5}$	1112	10.240
S20	4.955	$1x10^{-5}$	2430	14.742
S21B	8.283	$1x10^{-5}$	4227	18.534
S22A	5.681	$1x10^{-5}$	2953	14.067
S22B	3.064	$1x10^{-5}$	2543	37.925
S27	5.473	$1x10^{-5}$	N/A	N/A
S22E	0.791	$1x10^{-5}$	300	45.706
S22C2	0.546	$1x10^{-5}$	290	38.637

Table 8.14: Proposed Side Road Minor Drainage Networks

Drainage Network Ref. No.	Attenuation Details
S5B	Overlay - None Required
S16B	Online Attenuation
S17B	Online Attenuation
S31A	Overlay - None Required
S31B	Overlay - None Required
S31 C	Online Attenuation
S32	Attenuation Pond
S33	Attenuation Tank
S36A	Overlay - None Required
S36B	Overlay - None Required

Drainage Network Ref. No.	Attenuation Details
S37	Online Attenuation
S38	Overlay - None Required
S39	Overlay - None Required
S40	Overlay – Discharge to Ground
S41	Overlay - None Required
S44	Overlay - None Required
S45	Overlay - None Required

8.6.2 Existing Public Sewer Capacity

There are a number of drainage networks which will discharge to the existing public surface water sewer network. An assessment of the downstream capacities of the existing sewer network was undertaken and a comparison of the proposed new flow rates discharging to the networks compared. A summary of the flow rates and capacities are provided in **Table 8.15** below.

Table 8.15: Existing Sewer Network Capacity

Proposed Road Drainage Surface Water Network		**Downstream Receiving Sewer Details - Galway City/Galway County Council**							**Comparison**
Outfall Network Reference	**Peak Discharge Rate 1 in 100 (l/s)**	**Size (mm)**	**Data Source**	**US Invert Level (mAOD)**	**DS Invert Level (mAOD)**	**Length (m)**	**Gradient (1:X)**	**Hydraulic Capacity (l/s)**	**Capacity Check**
S11	7.8	300	Survey	53.033	51.718	43.358	33.0	193	OK
S14A	21	1200	Survey	26.72	26.67	35.126	702.5	305	OK
S22C1	5	900	Diversion	20.075	19.869	86.356	419.2	969	OK
S26	4.5								
S30	5.7	900	Survey	25.68	24.32	155.3	114.2	1660	OK
S29	5								
S16A	16.1	600	Survey	38.31	34.22	108	26.4	4758	OK
S17A	5.7	1500	Survey	29.91	29.54	33.75	91.2	7948	OK
S16B	4.7	450	Survey	39.43	39.09	43.399	127.6	279	OK
S17B	5.2	1500	GIS GCC Record	28.55	28.02	99.11	187.0	5538	OK
S31C	4.9	450	GIS GCC Record	43.509	40.417	57.165	18.5	755	OK
S32	5.6	375	Survey	47.74	47.44	27.8	92.7	208	OK
S33	5	600	Survey	48.945	48.888	27.13	476.0	314	OK
S37	5.4	450	GIS GCC Record	29.541	24.247	73.181	13.8	873	OK
S38	46.7	300	Survey	56.6	55.65	114.6	120.6	182	OK
S39	24.7	225	Survey	27.96	27	84.52	88.0	55.4	OK
S41	66.7	225	As Constructed	26.178	24.343	73.4	40.0	82.5	OK
S45	245	750	Proposed Realignment	48.799	48.655	52.187	361.0	648.1	OK

8.6.3 Pond Liners

The attenuation ponds in the western section of the proposed road development will be unlined.

In the eastern section of the proposed road development, where discharge is to ground via an infiltration basin, the infiltration basin will be unlined.

In the eastern section of the proposed road development, where discharge is to a surface water course, lake or public sewer, attenuation ponds will be lined using a impermeable membrane, geosynthetic clay liner or clay liner. The maximum permitted permeability of such liner is 1×10^{-11} m/s.

8.6.4 Pond Access & Maintenance

Access shall be provided to attenuation pond facilities for maintenance. Accesses are designed in accordance with to CC-SCD-02754 (RCD/2700/101) and the access tracks are in accordance with CC-SCD-00706 (RCD/700/6). The location of all access roads are outlined on drawings the general arrangement drawings **GCOB-100-D-000** to **GCOB-100-D-015** in Volume 2.

Where there is potential for open water bodies, e.g. at attenuation ponds, infiltration basins and wetland facilities a secure palisade fence will surround the body of open water to prevent unauthorised access. For further details of fencing refer to **Section 11** of this report.

8.7 Pollution Control

Potential pollution impacts posed by the proposed road development on the receiving water environment have been assessed in accordance DN-DNG-03065 - (HD 45) Road Drainage and the Water Environment. The methods employed assess the effects of routine runoff on surface water bodies and also groundwater bodies. Water quality impacts are particularly sensitive along the route of the proposed road development. There are four European sites that could be potentially affected by road runoff, Lough Corrib cSAC and Lough Corrib SPA and the downstream Galway Bay cSAC and Inner Galway Bay SPA a full assessment of the impacts are presented in the Natura Impact Statement (NIS) carried out as part of Phase 4 EIA/EAR and The Statutory Processes.

8.7.1 Routine Road Runoff

The Highways Agency Risk Assessment Tool (HAWRAT) was utilised to assess the risks posed by routine road runoff to streams and rivers. Based on the Annual Average Daily Traffic (AADT) and the Standard Average Annual Rainfall (SAAR) for the site, the tool calculates the runoff pollutant concentrations associated with a ten year series of rainfall events and the coincident flow in the receiving watercourse during each event. The tool displays either a Pass or Fail for each of the pollutant types considered. It should be noted that the assessment is carried out in the absence of pollutions treatment measures.

A summary of the results of the HAWRAT Assessment are presented in **Table 8.16** below.

Table 8.16: Results of the HAWRAT Road Outfall Water Quality Assessment of Receiving Surface Waters

Outfall Number /Catchment Reference	Water Hardness (mg/l CaCO3)	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 (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)

Outfall Number /Catchment Reference	Water Hardness (mg/l CaCO3)	Dissolved Copper (ug/l)	Dissolved Zinc (ug/l)	Sediment Deposition Index	Comment
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)
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

Various vegetated treatment systems for the drainage design were considered and a number of iterations and combinations (e.g. filter drains, grassed channels, wetlands, hydrocarbon interceptors etc.). The pollution removal efficiencies of the measures were considered and the various drainage design measures were added into the design of each network. **Table 8.17** is extracted from DN-DNG-03063 – (HDA 103) Vegetated Drainage Systems for Road Runoff and details the performance details for vegetated systems.

Table 8.17: Expected pollutant Removal Performance of Vegetated Systems

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

For the proposed road development, sustainable drainage systems (SuDS) are to be 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) should other conventional methods be used. In general, where the risk to groundwater is low combined filter drains will 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 road 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 the outfalls (e.g. carrier pipe with gullies, concrete surface water channels, slot drains etc.) Subsurface 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 the settlement of suspended solids. This will be achieved with lining the wetland using an impermeable membrane, geosynthetic clay liner or clay liner. The maximum permitted permeability of such liner is 1 x 10^{-11} m/s.

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.

Geometric details of the surface flow treatment wetlands are presented in **Table 8.18** below.

Table 8.18: Surface Flow Treatment Wetland Details

Drainage Network Ref. No.	**Wetland Treatment Volume - Vt (m^3)**	**Permanent Pool Depth (m)**
S1	192.75	0.6
S2	56.6	0.6
S3	192.15	0.6
S4A	93.6	0.6
S4B	10.35	0.6
S5A	229.8	0.6
S5B	N/A	N/A
S7A	36.6	0.6
S7B	160.5	0.6
S8	38.4	0.6
S9	178.8	0.6
S10	182.85	0.6
S11	235.8	0.6
S12	366.9	0.6
S13	94.8	0.6
S14A	329.85	0.6
S14B	97.8	0.6
S15	109	0.6
S16A	322.35	0.6
S16B	N/A	N/A
S17A	147.3	0.6
S17B	N/A	N/A
S18A	237	0.6
S18B	293.1	0.6

Drainage Network Ref. No.	Wetland Treatment Volume - Vt (m^3)	Permanent Pool Depth (m)
S19A	249	0.6
S19B	252.45	0.6
F19	N/A	N/A
S20	334.95	0.6
S21A	203.55	0.6
S21B	723	0.6
S22A	591.15	0.6
S22B	414.15	0.6
S22C1	N/A	N/A
S22C2	N/A	N/A
S22E	87.3	0.6
F24	N/A	N/A
S26	520.8	0.6
S27	N/A	N/A
S29	311.1	0.6
S30	687	0.6

In addition to the wetlands outlined above, a Class 1 Bypass hydrocarbon interceptor is specified downstream of the road network drainage and upstream of the inlet to the wetland. This will reduce the potential for oils and greases, which could potentially drip onto the carriageway from vehicles, gaining access to the receiving environment. Details of the proposed sizes of petrol interceptors are outlined in the drainage schedules in **Appendix A.8.5**.

A typical detail of the pollution control measures and pond arrangement are shown in Drawing **GCOB-500-D-301** in **Volume 2**.

8.7.2 Accidental Spillage Pollution Assessment

In accordance with DN-DNG-03065 - (HD 45) Road Drainage and the Water Environment a serious spillage pollution risk assessment was also carried out for each of the drainage networks discharging to surface watercourses and groundwater bodies. A summary of the risks are outlined in **Table 8.19** below.

Table 8.19: Serious Spillage Pollution Risk Assessment

Drainage Reference (Refer to Figures 8.2.1 to 8.2.15)	Road Chainage	Watercourse	Outfall Risk (%)	Combined Risk Probability
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

Drainage Reference (Refer to Figures 8.2.1 to 8.2.15)	Road Chainage	Watercourse	Outfall Risk (%)	Combined Risk Probability
S4A	1+475 - 1+900	Troscaigh Tributary	0.0023	
S4B	Link Road 0+580 - 0+680	Troscaigh Tributary	0.0001	
S5A	1+900 - 2+850	Troscaigh Stream	0.0068	
S5B	Link Road	Ditch - Troscaigh Tributary	0.0001	
S7A	2+850 - 3+050	Ditch – Troscaigh 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
S11	5+640 - 6+325	Existing storm sewer to Knocknacarra	0.0034	
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	River Corrib Tributary	0.0062	
S14B	8+250 - 8+525	River Corrib Tributary	0.0029	
S15	0 - 625 N59 link	Existing Ditch to River Corrib	0.0062	
S16A	625 – 1625 N59 link	To existing storm sewer	0.0073	
S16B	1500 – 1500 Letteragh Road upgrade	To existing storm sewer	0.0032	
S17A	1625 - 2210 N59 link	To existing storm sewer	0.0021	
S17B	2210 Gort Na Bró realignment	To existing storm sewer	0.0017	
S18A	8+525 - 9+250	River Corrib West Bank	0.0054	
S18B	9+250 - 10+150	River Corrib East Bank	0.0067	0.042
S19A	10+150 – 10+730	Lough Corrib Fen 1 (Menlough) GWB	0.00286	
S19B	10+730 – 11150	Lough Corrib Fen 1 (Menlough) GWB	0.00207	
S20	11420 - 12020	Clare-Corrib GWB	0.00322	

Drainage Reference (Refer to Figures 8.2.1 to 8.2.15)	Road Chainage	Watercourse	Outfall Risk (%)	Combined Risk Probability
S21A	Slip roads and N84 interchange	Ballindooley Lough/ Clare-Corrib GWB	0.0138	
S21B	12020 – 13630	Clare-Corrib GWB	0.01361	
S22A	13630 – 14350	Buried Landscape Clare-Corrib GWB/Clarinbridge GWB	0.01557	
S22B	14350 – 14950	Clarinbridge GWB	0.0038	
S22C2	Parkmore Link Road	Clarinbridge GWB	0.00045	
S22E	Slip roads & N83 Loops	Clarinbridge GWB	0.00006	
S40	Side Road	Lough Corrib Fen 1 (Menlough) GWB	0.00	
S43	9150	River Corrib	0.00	
S45	15150	Existing Storm Sewer	0.00	

Generally, the acceptable risk of a serious pollution incident occurring will be where the annual probability is predicted to be less than 1% (Probability less than 0.01). Where the predicted risk is higher than this, spillage prevention measures are provided. Where runoff discharges within close proximity to designated sites (e.g. SPA or SACs) or water abstraction for drinking water supplies are present, a higher standard of protection is required and spillage prevention measures are also provided at these locations.

A minimum emergency spill containment volume of $25m^3$ will be provided at all outfall locations as per DN-DNG03022 (HD33) Drainage Systems for National Roads.

A summary indicating the design measures incorporated into each drainage network is contained in **Table 8.20** below.

Table 8.20: Summary Pollution Control and Attenuation Measures

Drainage Network Ref. No.	Outfalling to	Proposed Pollution Control Measures
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

Drainage Network Ref. No.	Outfalling to	Proposed Pollution Control Measures
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.
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

Drainage Network Ref. No.	Outfalling to	Proposed Pollution Control Measures
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
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

8.8 Flood Risk

To inform the Flood Risk Assessment (FRA) for the proposed road development, the website floodmaps.ie and the pFRA and CFRAM flood mapping were consulted as initial screening. For the river crossings, hydraulic flood modelling was carried out to estimate the design flood level and potential impact of the proposed road development, the FRA can be found in **Appendix A.8.6**.

Using a system of flow control and attenuation storage, it is proposed that there will be no worsening of flow rates up to the 1 in 100-year return storm. It will be demonstrated that the post development peak discharge rates for the critical duration storm event at the scheme boundaries will be less than the pre-development greenfield runoff discharge rates for the 1 in 100-year return period as set out in DN-DNG-03022 (HD33) Drainage Systems for National Roads.

The section of the River Corrib at the crossing point of the proposed road development has been modelled in the CFRAM detailed study and predictions for the 100-year and 1000-year events are available at the crossing location. The full spanning structure does not encroach the effective floodplain area of the River Corrib at the crossing point. The potential impact of the proposed River Corrib bridge structure on flooding and flood risk has been shown through detailed modelling presented in the Section 50 Hydrology Report to be imperceptible. Section 50 approval for the proposed road development Corrib Bridge structure has been granted by the OPW and the report is located in **Appendix A.8.1**.

There is minor encroachment by the proposed road development road embankment 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.

At total of 16 small watercourses and drains will be crossed by the N6 GCRR 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 and the report is located in **Appendix A.8.1.**

There is a slight encroachment on the Ballindooley Lough flood zone by the embankment of the proposed road development predicted and the effect of this has been assessed as minor and the impact on flooding assessed as slight permanent impact.

The potential flood risk to the proposed Lackagh Tunnel is rated as representing a moderate flood risk. This risk is associated with the potential for elevated groundwater table within the quarry under more extreme 1000-year flood events and climate change conditions to potentially enter the tunnel via the quarry entrance side. As the proposed road development traverses through the quarry, it will reduce the available storage and increase pluvial ponding depths contained within the lower bench of the quarry which potentially increases flood levels local to the quarry. The potential impact is significant but has been reduced to slight through implementation in the road design of flood risk mitigation measures involving bunding/tanking of the entrance and raising road elevations on and approaches which thereby prevents flood waters from the quarry gaining access to the tunnel.

The proposed N59 Link Road South from Ch. 1+550 to Ch. 2+200 and the proposed upgrade and 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 various nodal points and the micro-drainage program ran which showed ample capacity at the 1000-year flood event within the storm pipe as not to result in flooding in the vicinity of the proposed link road 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 on 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 existing culverted Knocknacarra Stream will be attenuated to the natural greenfield runoff rates and therefore will not impact on flood flows and flooding.

Road drainage outfalls discharging to receiving surface and groundwaters sources without flood flow attenuation could increase downstream and local flooding at the discharge points, particularly so for the smaller drains and infiltration areas. This has been mitigated for in the drainage design through suitably sized attenuation ponds and outlet flow controls to limit discharge.

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.

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. The assessment indicates that these pluvial flood sources are very minor in respect to contributing drainage area and the extent of the flood area. Any partial or full encroachment of these features have been catered for in the proposed road drainage solution without increasing flood risk and the potential impact is assessed as slight to imperceptible.

A relatively large pluvial flood source along the N83 Tuam Road and adjacent low-lying lands to the west, and a small section to the east near the proposed N83 Tuam Road Junction, has a significant flood risk with over seven houses at risk along the N83 Tuam Road. The proposed road development potentially encroaches on the pluvial Flood Zone A (high probability of flooding zone) with the potential for 30% loss in available flood storage within these pluvial flood prone lands. The proposed road development will also introduce a significant additional paved area to the contributing catchment of this flood zone. Without suitable mitigation, the proposed road development has a potential at this location to remove flood storage and significantly increase drainage runoff to this flood area and thus potentially worsen the flood risk at this location. This potential impact in the absence of mitigation is classified as a profound impact in the EIA Report, with potential to increase flood levels and the frequency of flooding on the existing N83 Tuam Road and adjacent residential dwellings and lands. **Section 8.8.1** outlines further details on the N83 Tuam Road flood risk and outlines the proposed flood risk mitigation measures.

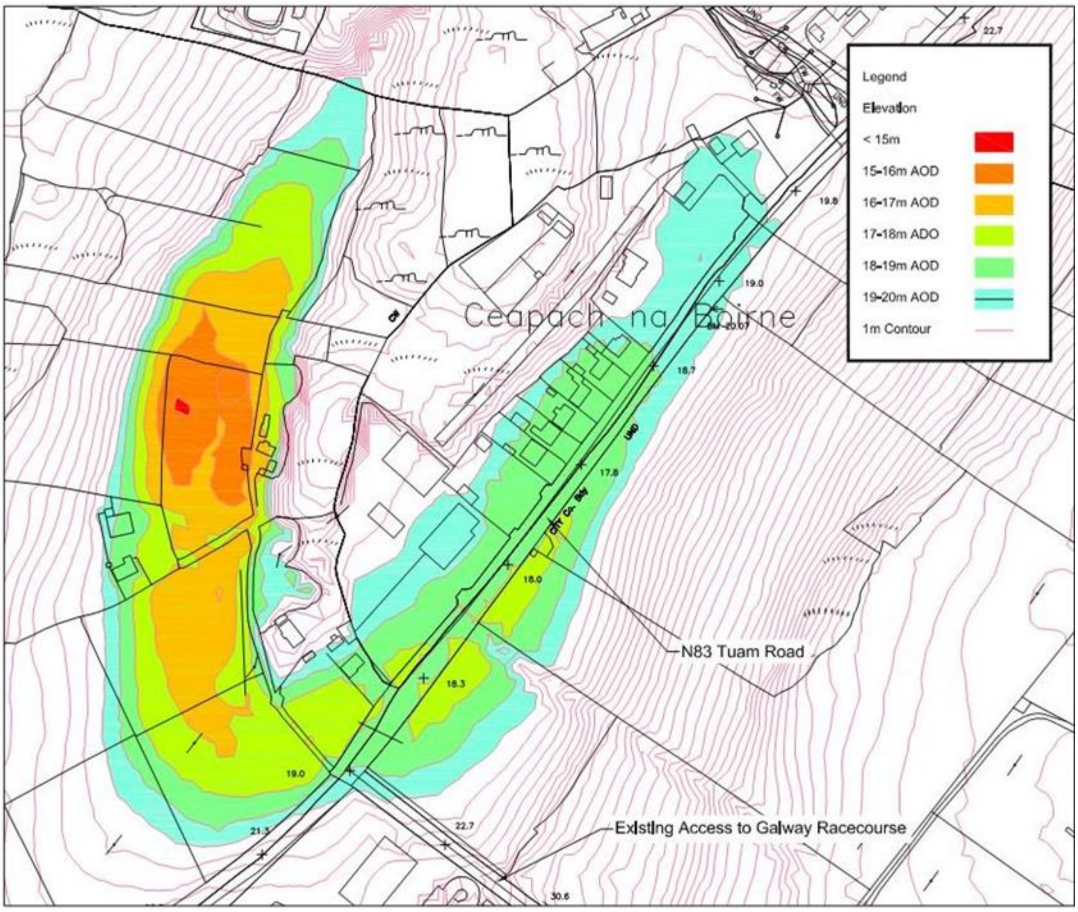
8.8.1 Flood Compensation Storage Design at N83

The existing contributing drainage area of the Twomileditch drainage basin on the N83 Tuam Road, based on lidar DTM data, is approximately 110ha, of which 80ha is contributing to the anecdotal N83 Tuam Road flooding event. The catchment is small and steep and as such exhibits flash flood characteristics. The proposed road development passes through this catchment and has the potential to exacerbate the existing flood risk scenario as outlined above.

Currently, in a flood event scenario, the existing method of dealing with the flooding on the N83 Tuam Road by the local authority is to pump the water that ponds in the low lying fields east of the N83 Tuam Road, adjacent to the Galway Racecourse entrance, using a portable pump. This discharges into a nearby surface water manhole located in the City North Business Park and drains by gravity to the Terryland River.

The natural low lying land where flood waters accumulate is strategic for the purpose of natural flood storage for the Twomileditch area. The proposed road development encroaches on this natural flood storage area and will result in a loss of 26% at the 18m AOD contour in storage volume. As part of the design of the proposed road development, flood relief mitigation measures are adopted to ensure that the flood risk to adjacent residential properties and infrastructure is not increased. The remaining low lying lands that form a local basin to the north of the proposed junction will continue to act as natural flood storage. The critical elevation for the floodwater is 18m AOD, as above this level the floodwater threatens the N83 Tuam Road and some of the adjacent residential properties in Twomileditch, refer to **Figure 8.2** for further detail on the existing topography of the area.

Figure 8.2: Twomileditch Basin with 1m Contours from 16m – 20m AOD displayed



A number of measures have been incorporated into the design, refer to Drawing **GCOB-500-D-600** in **Volume 2** for further detail, to mitigate any increase in flood risk caused by the N6 GCRR which are as follows:

- The removal of slip roads from the proposed N83 Tuam Road Junction design in order to reduce the footprint within the floodplain area and the loss of natural storage volume for floodwater
- The provision of drainage infrastructure to TII standards along the section of the N83 Tuam Road that is to be resurfaced, widened and regraded as part of the N6 GCRR project
- The provision of pre-earthworks drainage adjacent to the N83 Tuam Road to intercept overland flow off the steep hill slopes to the east of the N83 Tuam Road
- The embankment of the mainline and slip roads through the low-lying areas to be comprised of porous permeable fill up to the predicted 1 in 100-year top water level + 500mm freeboard
- The provision of an additional flood storage area and volume to the east of the N83 Tuam Road

- The installation of culverts through the road embankments in order to retain the connectivity of the flood storage lands both existing and proposed and to link them to the proposed floodwater pumping station and sump area
- The provision of a pumping station to pump floodwater to an existing storm water sewer at the City North Business Park which discharges to the Terryland River. Pumped flow rate equals 250 l/s

The pumping rate and storage is designed such that the 100-year flood event plus a 20% increase in flood volume, to account for climate change, will not result in an increase in flood levels.

A wide swale is proposed along the eastern boundary of the N83 Tuam Road to intercept the runoff from the hill slope. The swale will outfall via infiltration through its base to allow the runoff to infiltrate to ground and during large storm events will convey the flood volume safely to the proposed artificial flood storage area. The connectivity between the new artificial storage and retained natural flood storage area will be achieved through the provision of a series of 1200mm diameter pipes beneath the eastbound slip road, mainline and N83 Tuam Road.

Details of the proposed conveyance culverts are provided in **Table 8.21** below.

Table 8.21: Flood Conveyance Culverts

Culvert Reference	**Chainage**	**Referenced Mainline / Side Road**	**Location X**	**Location Y**	**Culvert Diameter / Width x Height**	**Approx. Length (m)**
C13/03	13800	Mainline	532712.4	728264.3	1.2m ϕ	78.9
C13/04	13900	Side Road Tuam Road	532825.7	728217.0	1.2m ϕ	24.0
C14/01	14000	Mainline	532902.0	728280.7	1.2m ϕ	107

The additional artificial storage area volume is sized based on the critical rain storm events for the 5 and 10-year return periods. The artificial area contains a sump and permanent pumping station which will activate when a minimum depth of water is contained in the storage area. The pumping rate has been designed to ensure floodwaters do not exceed 18mAOD during the critical storm duration computed to be 12 hours duration. A 60% runoff rate is assumed for the purpose of calculating the runoff based on the local catchment characteristics.

The natural flood storage area below 18m AOD with the N6 GCRR in place, provides a volume of storage of 28,270m^3 with the artificial storage area providing additional storage capacity of 8,030m^3.

The attenuated flood waters will be pumped to the 900mm surface water sewer in City North Business Park where it will discharge by gravity to the Terryland

Stream, replicating the current method of dealing with the large return period event's flood water. Galway City Council have been consulted with in relation to the connection to the surface water sewer in City North Business Park and have agreed in principal to the pumping of the flood water, no issue with the capacity of the sewer is envisaged. Sensitivity analysis has been undertaken to determine the effect of the additional discharge to the Terryland Stream during storm events as detailed in the FRA, refer to **Appendix A.8.6**.

9 Services & Utilities

9.1 General

The existing infrastructure of a number of utility and service providers is impacted by the proposed road development. The delivery of the proposed road development shall ensure that there are no permanent disruptions to services provided by these providers and that all temporary disruptions are minimised. Where service diversions are required to facilitate the development, all design works and construction works must be carried out in coordination with the relevant statutory bodies and utility and service providers.

As part of Phase 3 Design, the following statutory bodies and service providers were consulted:

- SSE Airtricity/Eirgrid
- E-Net
- BT
- EIR
- Gas Networks Ireland
- Three Networks Ireland
- Virgin Media
- Irish Water
- Galway City Council (GCiC) Water Services Department
- Galway County Council (GCC) Water Services Department
- Industrial Development Authority Ireland (IDA)
- Vodafone
- ESB
- ESBI

All known potential conflicts between the proposed N6 Galway City Ring Road and the existing and future planned services have been identified and the statutory body or service provider has been consulted as to how best to protect or divert their services. The proposed measures are outlined in this chapter. For the locations of all existing utilities refer to Drawings **GCOB-2700-D-000** to **015** in **Volume 2**.

9.2 Service Impacts

This section of the report presents the locations of potential impact to services and the general measures that have been identified as being necessary to undertake in agreement with the respective parties.

During detailed design and construction of the scheme the appointed contractor shall re consult and comply with the requirements of the relevant bodies and service providers listed in **Section 9.1** with respect to service realignments and diversions necessitated by the project.

Following on from the consultations with service providers the following utilities have been identified as having infrastructure which conflict with the route of the proposed road development:

- Electricity Supply – ESB & ESBI, SSE Airtricity
- Gas – Gas Networks Ireland
- Telecommunication – Eir, Virgin Media, E-Net, BT, Three Networks Ireland, Vodafone
- Sanitary and Water Services – Irish Water and Galway City Council Water Services Department and IDA

9.2.1 Electricity Supply

There are a number of conflicts between electricity services and the proposed road development. These services are maintained by ESBI and ESB with the 110kV and 220kV lines falling under the remit of ESBI and the 38kV lines and lower voltage lines falling under the remit of ESB. There are no conflicts with any 220kV lines as part of the proposed road development, however some of the 10kV, 38kV and 110kV electricity lines are in conflict with the proposed alignment of the proposed road development in various locations. The general measures for mitigation of such conflicts consist of overhead cables being diverted and placed underground, where possible. There may be a need to relocate existing poles or include new pylons at certain locations.

9.2.1.1 ESBI

There are a total of 7 conflicts between the proposed road development and the 110kV lines, of which 2 will require diversion works and 2 will require new pole/pylon sets. The locations at which conflicts occur between ESBI 110 kV services and the proposed N6 Galway City Ring Road are shown on the Drawings **GCOB-2700-D-280** to **287** in **Volume 2**. Also shown are the proposed accommodation measures. The locations at which conflicts occur with the ESB lines are shown below in **Table 9.1** below.

Table 9.1: Location of ESBI line conflicts with the proposed N6 GCRR

Ref	ESBI Line Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
ESBI 03/01	HV OH	3+960	Protect and maintain existing	146m
ESBI 06/01	HV UG	6+200	Protect and maintain existing	291m
ESBI 13/01	HV OH	13+520	Protect and maintain existing. 2 new pole sets required	111m
ESBI 14/01	HV OH	14+000	Protect and maintain existing. 1 new pylon and one new pole set	1040m

Ref	ESBI Line Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
ESBI 16/01	HV OH	16+250	Protect and maintain existing	261m & 262m
ESBI 16/02	HV OH	16+400	Diversion Required. 3 new pylons and 2 new pole sets required	648m
ESBI 16/03	HV OH	16+400	Diversion Required. 3 new pylons and 2 new pole sets required	641m

9.2.1.2 ESB

There is a total of 25 conflicts with 38kV voltage lines, of which 8will require diversion works and 2 will require new pole sets. A further 104 low and medium voltage lines are impacted by the proposed N6 GCRR, of these 40 will require diversion works.

The locations at which conflicts occur between ESB 38kV services and the proposed N6 Galway City Ring Road are shown on the Drawings **GCOB-2700-D-290** to **309** in **Volume 2**. Also shown are the proposed accommodation measures. The locations at which conflicts occur with the ESB lines are shown below in **Table 9.2** below.

Table 9.2: Location of ESB 38kV line conflicts with the proposed N6 GCRR

Ref	ESB Line Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
ESB HV 00/01	HV OH	0+900	Protect and maintain existing	119m
ESB HV 01/01	HV OH	1+000	Protect and maintain existing	22m
ESB HV 03/01	HV OH	3+825	Protect and maintain existing. 2 new poles required	116m
ESB HV 05/01	HV OH	5+750	Protect and maintain existing	22m
ESB HV 06/01	HV UG	6+385	Protect and maintain existing	18m
ESB HV 06/02	HV OH	6+550	Protect and maintain existing. 1 new pole required	155m
ESB HV 06/03	HV UG	6+650	Protect and maintain existing	290m
ESB HV 06/04	HV OH	6+950	Divert underground. 1 new tower and 1 new pole	33m
ESB HV 06/06	HV OH	6+550	Raise existing service over proposed road. 2 new poles required	76m

Ref	ESB Line Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
ESB HV 06/07	HV UG	6+350	Divert underground	166m
ESB HV 06/08	HV UG	6+350	Protect and maintain	122m
ESB HV 07/01	HV OH	7+850	Protect and maintain existing	30m
ESB HV 08/01	HV OH	8+270	Diversion and 2 new poles required	127m
ESB HV 08/02	HV UG	8+270	Underground diversion to connect with ESB HV 08/02 overhead diversion. 3 new underground chambers and 1 new pole required	285m
ESB HV 08/03	HV OH	8+550	Overhead diversion. 1 new tower	25m
ESB HV 09/01	HV OH	9+450	Protect and maintain existing	676m
ESB HV 10/01	HV OH	10+550	Protect and maintain existing	59m
ESB HV 11/01	HV OH	11+050	Protect and maintain existing	147m
ESB HV 13/01	HV OH	13+830	Overhead diversion and 5 new poles required	317m
ESB HV 14/01	HV OH	14+400	Protect and maintain existing	135m
ESB HV 14/02	HV OH	14+470	Protect and maintain existing	25m
ESB HV 14/03	HV OH	14+470	Protect and maintain existing	44m
ESB HV 14/04	HV UG	14+500	Protect and maintain existing	277m
ESB HV 15/01	HV UG	15+860	Protect and maintain existing	427m
ESB HV 16/01	HV OH	16+210	Underground diversion of existing overhead service required	1065m

The locations at which conflicts occur between ESB low and medium voltage (10kV or less) services and the proposed N6 Galway City Ring Road are shown on the Drawings **GCOB-2700-D-360** to **396 i**n **Volume 2**. Also shown are the proposed accommodation measures. The locations at which conflicts occur with these ESB lines are shown below in **Table 9.3** below.

Table 9.3: Location of ESB low and medium voltage line conflicts with the proposed N6 GCRR

Ref	**ESB Line Type**	**Approx. Chainage (m)**	**Provisional measures**	**Affected Lengths (m)**
ESB 00/01	LV OH	0+000	Protect and maintain	110m
ESB 00/02	MV OH	0+000	Overhead diversion required	145m
ESB 00/03	MV OH	0+000	Overhead diversion required	181m
ESB 00/04	MV OH	0+000	Underground diversion required	60m
ESB 00/05	MV OH	0+000	Underground diversion required	109m
ESB 01/01	MV OH	1+000	Protect and maintain existing	242m
ESB 01/02	MV OH	1+270	Underground diversion required	92m
ESB 01/03	LV OH	1+270	Overhead diversion and 16 new poles required	705m
ESB 01/04	MV/LV OH	1+650	Overhead diversion required	50m
ESB 01/05	LV OH	1+250	Protect and maintain existing	69m
ESB 01/06	MV OH	1+450	Protect and maintain existing	59m
ESB 01/07	MV OH	1+150	Protect and maintain existing	15m
ESB 01/08	LV OH	1+100	Overhead diversion required	75m
ESB 01/09	MV OH	1+275	Protect and maintain existing	61m
ESB 01/10	MV OH	1+050	Protect and maintain existing	15m
ESB 01/11	MV OH	1+040	Protect and maintain existing	10m
ESB 02/01	LV OH	2+325	Protect and maintain existing	25m
ESB 03/01	LV OH	3+325	Protect and maintain existing	70m
ESB 04/01	MV OH	4+440	Overhead diversion required	175m
ESB 04/02	MV/LV OH	4+440	Protect and maintain existing	15m
ESB 04/03	LV OH	4+520	Overhead diversion required	79m

Ref	ESB Line Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
ESB 04/04	LV OH	4+450	Protect and maintain existing	51m
ESB 04/05	LV OH	4+550	Protect and maintain existing	44m
ESB 04/06	LV OH	4+460	Protect and maintain existing	176m
ESB 04/07	LV OH	4+460	Protect and maintain existing	19m
ESB 05/01	LV OH	5+625	Protect and maintain existing	20m
ESB 05/02	MV OH	6+020	Underground diversion required	97m
ESB 05/03	LV OH	5+650	Overhead diversion required	23m
ESB 05/04	LV OH	5+640	Overhead diversion required	36m
ESB 05/05	LV OH	5+650	Overhead diversion required	59m
ESB 05/06	LV OH	5+640	Overhead diversion required	49m
ESB 06/01	MV/LV UG	6+300	Protect and maintain existing	340m
ESB 06/02	MV/LV UG	6+330	Protect and maintain existing	340m
ESB 06/03	MV/LV UG	6+400	Protect and maintain existing	75m
ESB 06/04	MV/LV UG	6+500	Protect and maintain existing	52m
ESB 07/01	MV/LV UG	7+050	Protect and maintain existing	105m
ESB 07/02	MV/LV OH	7+230	Underground diversion required	210m
ESB 07/03	MV/LV UG	7+230	Protect and maintain existing	13m
ESB 07/04	LV OH	7+370	Protect and maintain existing	102m
ESB 07/05	MV OH	7+400	Protect and maintain existing	48m
ESB 07/06	LV OH	7+450	Protect and maintain existing	20m
ESB 07/07	LV OH	7+450	Underground diversion required	115m
ESB 07/08	LV OH	7+480	Overhead diversion required	112m

Ref	ESB Line Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
ESB 07/09	LV OH	7+480	Protect and maintain existing	51m
ESB 07/10	LV OH	7+230	Protect and maintain existing	48m
ESB 07/11	LV OH	7+230	Protect and maintain existing	9m
ESB 08/01	MV OH	8+100	Overhead diversion required	224m
ESB 08/02	MV OH	8+200	Protect and maintain existing	16m
ESB 08/03	MV OH	8+220	Overhead diversion required	65m
ESB 08/04	LV OH	8+350	Protect and maintain existing	21m
ESB 08/05	MV/LV UG	8+360	Underground diversion required	205m
ESB 08/06	MV/LV UG	8+450	Underground diversion required	60m
ESB 08/07	LV OH	8+500	Protect and maintain existing	174m
ESB 08/08	MV/LV UG	8+510	Underground diversion required	80m
ESB 08/09	LV OH	8+550	Protect and maintain existing	20m
ESB 08/10	MV OH	8+450	Protect and maintain existing	56m
ESB 08/11	MV OH	8+480	Protect and maintain existing	70m
ESB 08/12	LV OH	8+300	Underground diversion required	31m
ESB 08/13	LV OH	8+290	Overhead diversion required	50m
ESB 08/14	LV OH	8+270	Overhead diversion required	37m
ESB 08/15	MV OH	8+250	Protect and maintain existing	46m
ESB 08/16	MV/LV OH	8+950	Protect and maintain existing	34m
ESB 08/17	MV/LV OH	8+750	Protect and maintain existing	15m
ESB 10/01	MV OH	10+120	Underground diversion required	106m
ESB 10/02	MV OH	10+150	Overhead diversion required	20m

Ref	ESB Line Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
ESB 10/03	MV OH	10+150	Overhead diversion required	54m
ESB 12/01	MV OH	12+050	Overhead diversion required	80m
ESB 12/02	LV OH	12+070	Protect and maintain existing	25m
ESB 12/03	LV OH	12+080	Overhead diversion required	33m
ESB 12/04	MV OH	12+000	Protect and maintain existing	28m
ESB 12/05	MV OH	12+020	Overhead diversion required	127m
ESB 12/06	MV OH	12+060	Protect and maintain existing	55m
ESB 12/07	LV OH	12+120	Protect and maintain existing	27m
ESB 12/08	LV OH	12+120	Protect and maintain existing	46m
ESB 13/01	MV OH	13+060	Protect and maintain existing	100m
ESB 13/02	LV OH	13+070	Overhead diversion required	86m
ESB 13/03	LV OH	13+130	Protect and maintain existing	124m
ESB 13/04	LV OH	13+260	Overhead diversion required	35m
ESB 13/05	LV OH	13+260	Protect and maintain existing	129m
ESB 13/06	MV OH	13+700	Underground diversion required	565m
ESB 13/07	MV/LV UG	13+850	Protect and maintain existing	55m
ESB 13/08	MV/LV UG	13+950	Protect and maintain existing	45m
ESB 13/09	MV OH	13+660	Protect and maintain existing	21m
ESB 13/10	MV OH	13+060	Protect and maintain existing	26m
ESB 13/11	LV OH	13+540	Protect and maintain existing	33m
ESB 14/02	MV/LV UG	14+450	Protect and maintain existing	125m
ESB 14/03	MV/LV UG	14+610	Overhead diversion required.	73m

Ref	ESB Line Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
ESB 14/04	MV/LV UG	14+630	Underground diversion required. Lower existing	105m
ESB 14/05	MV/LV UG	14+560	Protect and maintain existing	227m
ESB 15/01	MV/LV UG	15+000	Protect and maintain existing	20m
ESB 15/02	MV/LV UG	15+020	Underground diversion required	304m
ESB 15/03	MV/LV UG	15+150	Protect and maintain existing	20m
ESB 15/04	MV/LV UG	15+150	Protect and maintain existing	20m
ESB 15/05	MV/LV UG	15+180	Protect and maintain existing	276m
ESB 15/06	MV/LV UG	15+700	Protect and maintain existing	150m
ESB 15/07	MV/LV UG	15+720	Underground diversion required	200m
ESB 15/08	MV/LV UG	15+870	Protect and maintain existing	25m
ESB 15/09	MV/LV UG	15+880	Underground diversion required	90m
ESB 15/10	MV/LV UG	15+880	Protect and maintain existing	152m
ESB 15/11	MV/LV UG	15+950	Protect and maintain existing	12m
ESB 15/12	MV/LV UG	15+740	Protect and maintain existing	44m
ESB 15/13	MV/LV UG	15+740	Protect and maintain existing	4m
ESB 15/14	MV/LV UG	15+740	Protect and maintain existing	15m
ESB 16/01	MV/LV UG	16+550	Protect and maintain existing	105m

9.2.1.3 SSE Airtricity

During the design phase of the N6 GCRR a new 110kV underground electricity line was installed to supplement the National Grid and to serve Galway Wind Park in Connemara. The new underground line runs from Connemara to the Ballybrit substation in Galway City. At the time of writing this report the underground power line is operational and taken in charge by ESB networks as the Transmission Asset Owner (TAO) and operated by Eirgrid as the Transmission System Operator (TSO). If any works in the future are required along this line, such as diversions, an application to ESB Networks will need to be made to obtain permission for the works.

The 4 locations at which conflicts occur between SSE 110kV underground services and the proposed N6 Galway City Ring Road are shown on the Drawings **GCOB-2700-D-350** to **354** in **Volume 2**. All conflicts with the SSE 110kV underground service can be mitigated through protecting and maintaining the existing service and will not require any further accommodation measures or diversions. The locations at which conflicts occur with these SSE 110kV underground service are shown below in **Table 9.4** below.

Table 9.4: Locations of SSE Airtricity line conflictions with the proposed N6 GCRR

Ref.	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
SSE 08/01	UG Cable	8+450	Protect and maintain existing	348m
SSE 08/02	UG Cable	8+500	Protect and maintain existing	390m
SSE 09/01	UG Cable	9+120	Protect and maintain existing	115m
SSE 10/01	UG Cable	10+120	Protect and maintain existing	279m

9.3 Gas

9.3.1 Gas Networks Ireland

The proposed road development is in conflict with gas pipelines in 12 locations and these locations have been confirmed with Gas Networks Ireland. Out of the 12 conflicts only 2 require diversion works. A 315 PE bar pipeline runs along the local School Road in Castlegar and will require a temporary diversion during the construction of the proposed road development. Similarly, a 125 PE bar pipeline is in conflict with the proposed road development along Rahoon Rd and its vertical alignment will need to be lowered. There are further crossings of gas pipelines at Bóthar Diarmuida, Galway Retail Park and Parkmore Business Park.

All work on the gas pipeline is to be carried out to Gas Networks Ireland requirements, to standard details pertaining to existing services on the route and to proposed construction details, as provided by Gas Networks Ireland. Gas Networks Ireland require a minimum lead in time of 12 months before their works start on site. The design, planning and construction of these diversions could take up to 12 months to complete.

The locations at which conflicts occur between the Gas Networks Ireland pipelines and the proposed road development are shown in Drawings **GCOB-2700-D-250** to **256** in **Volume 2**. Also shown are the proposed accommodation measures. The locations at which conflicts occur with the Gas Networks Ireland services are shown below in **Table 9.5** below.

Table 9.5: Locations of Gas Networks Ireland conflictions with the proposed N6 GCRR

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
GAS 06/01	UG Pipe	6+200	Protect and maintain existing	320m
GAS 06/02	UG Pipe	6+250	Protect and maintain existing	50m
GAS 06/03	UG Pipe	6+500	Protect and maintain existing	55m
GAS 06/04	UG Pipe	6+520	Proposed Diversion, lower gas line elevation	95m
GAS 06/05	UG Pipe	6+550	Protect and maintain existing	105m
GAS 06/06	UG Pipe	6+550	Protect and maintain existing	410m
GAS 13/01	UG Pipe	13+100	Protect and maintain existing	15m
GAS 13/02	UG Pipe	13+150	Temporary diversion required during construction. Relay in new School Road bridge deck	240m
GAS 13/03	UG Pipe	13+120	Protect and maintain existing	59m
GAS 13/04	UG Pipe	13+130	Protect and maintain existing	33m
GAS 14/01	UG Pipe	14+500	Protect and maintain existing	60m
GAS 16/01	UG Pipe	16+650	Protect and maintain existing	25m

9.4 Telecommunications

9.4.1 Eir

Eir have a number of overhead and underground services that are affected by the proposed road development. The locations at which conflicts occur between Eir services and the proposed road development are shown in Drawings **GCOB-2700-D-200** to **240** in **Volume 2**. Also shown are the proposed diversions and necessary works. The locations at which conflicts occur with the Eir services are shown below in **Table 9.6**.

Table 9.6: Locations of Eir line conflictions with the proposed N6 GCRR

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
EIR 00/01	OH Cable	0 +000	Divert around roundabout into verge/footpath with 130m diversion	130m
EIR 00/02	OH Cable	0+000	Maintain existing	58m
EIR 00/03	OH Cable	0+000	Maintain existing	85m
EIR 01/01	OH Cable	1+140	Maintain existing	225m
EIR 01/02	OH Cable	1+570	Maintain existing	380m
EIR 02/01	OH Cable	2+720	Maintain existing	65m
EIR 02/02	OH Cable	2+840	Divert around roundabout	260m
EIR 02/03	OH Cable	2+840	Protect and maintain.	95m
EIR 03/01	OH Cable	3+250	Maintain existing	110m
EIR 03/02	OH Cable	3+325	Diversion of overhead lines required. Underground and place in bridge deck	180m
EIR 03/03	OH Cable	3+350	Maintain existing	60m
EIR 03/04	OH Cable	3+550	New pole relocation, re sag line as required	N/A
EIR 04/01	OH Cable	4+450	Maintain existing	425m
EIR 05/01	OH Cable	5+620	Maintain existing	15m
EIR 05/02	OH Cable	5+620	Diversion of overhead lines required. Overhead lines to be undergrounded	120m
EIR 06/01	UG Cable	6+250	Maintain existing	820m
EIR 06/02	OH Cable	6+330	Diversion of overhead lines required. Overhead lines to be undergrounded	180m
EIR 06/03	OH Cable	6+300	Diversion required. Overhead lines re-routed and undergrounded	165m
EIR 06/04	UG Cable	6+320	Maintain existing	63m
EIR 06/05	UG Cable	6+600	Maintain existing	107m
EIR 06/06	UG Cable	6+720	Maintain existing	365m
EIR 07/01	OH Cable	7+250	Diversion required. Overhead lines to be undergrounded	245m
EIR 07/02	OH Cable	7+450	Maintain existing	90m
EIR 08/01	UG Cable	8+450	Maintain existing	395m
EIR 08/02	UG Cable	8+470	Maintain existing	406m
EIR 08/03	UG Cable	8+580	Maintain existing	100m
EIR 08/04	UG Cable	8+550	Underground diversion required	51m
EIR 10/01	OH Cable	10+100	Diversion required. Overhead lines to be undergrounded.	100m
EIR 12/01	OH Cable	12+100	Maintain existing	50m
EIR 12/02	OH Cable	12+120	Diversion required. Overhead lines to be undergrounded.	277m

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
EIR 12/03	OH Cable	12+070	Maintain existing	94m
EIR 13/01	UG Cable	13+170	Diversion required. Underground ducts to be re-routed and placed in bridge deck	240m
EIR 13/02	UG Cable	13+250	Maintain existing	115m
EIR 13/03	UG Cable	13+950	Maintain existing	1149m
EIR 13/04	UG Cable	13+965	Maintain existing	1100m
EIR 13/05	UG Cable	13+800	Maintain existing	40m
EIR 13/06	UG Cable	13+900	Maintain existing	91m
EIR 14/01	UG Cable	14+350	Maintain existing	452m
EIR 14/02	UG Cable	14+500	Maintain existing	110m
EIR 15/01	UG Cable	15+045	Underground diversion required	297m
EIR 15/02	UG Cable	15+090	Maintain existing	148m
EIR 15/03	UG Cable	15+700	Maintain existing	230m
EIR 15/04	UG Cable	15+700	Underground diversion required	219m
EIR 15/05	UG Cable	15+870	Underground diversion required	32m
EIR 15/06	UG Cable	15+870	Maintain existing	381m
EIR 15/07	UG Cable	15+900	Maintain existing	355m
EIR 16/01	UG Cable	16+250	Underground diversion required	693m
EIR 16/02	UG Cable	16+600	Maintain existing	300m

9.4.2 Virgin Media

Virgin Media have a number of underground fibre optic cables running in ducting along existing roads within scheme study area. There are a total of 11 conflicts between Virgin Media ducts and the proposed road development, of which only 3 will require diversions. The general mitigation works required are to replace the existing ducts with new ducting in a suitable location.

The locations at which conflicts occur between Virgin Media services and the proposed road development are shown in Drawings **GCOB-2700-D-340** to **346** in **Volume 2**. Also shown are the proposed diversions and necessary works. The locations at which conflicts occur with the Virgin Media services are shown below in **Table 9.7**.

Table 9.7: Locations of Virgin Media line conflictions with the proposed N6 GCRR

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
VIR 06/01	UG Cable	6+300	Protect and maintain existing	130m
VIR 06/02	UG Cable	6+300	Protect and maintain existing	125m
VIR 06/03	UG Cable	6+300	Protect and maintain existing	25m

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
VIR 06/04	UG Cable	6+300	Protect and maintain existing	50m
VIR 06/05	UG Cable	6+600	Protect and maintain existing	105m
VIR 07/01	UG Cable	7+280	Lower existing	30m
VIR 07/02	UG Cable	7+280	Protect and maintain existing	420m
VIR 07/03	UG Cable	7+280	Lowered and relocated into verge/footpath	290m
VIR 15/01	UG Cable	15+180	Protect and maintain existing	28m
VIR 15/02	UG Cable	15+160	Lowered and relocated into verge/footpath	63m
VIR 15/03	UG Cable	15+140	Protect and maintain existing	81m

9.4.3 E-Net

E-Net have a number of fibre optic cables running in ducting along existing roads within the proposed road development study area as part of the metropolitan area network (MAN). There are 19 conflicts between the E-Net services and the proposed road development, of which only 5 require diversions.

The locations at which conflicts occur between E-Net services and the proposed road development are shown in Drawings **GCOB-2700-D-260** to **275** in **Volume 2**. Also shown are the proposed diversions and necessary works. The locations at which conflicts occur with the E-Net services are shown below in **Table 9.8**.

Table 9.8: Locations of E-Net line conflictions with the proposed N6 GCRR

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
ENT 06/01	UG Cable	6+300	Protect and maintain existing	255m
ENT 06/02	UG Cable	6+400	Protect and maintain existing	40m
ENT 06/03	UG Cable	6+600	Protect and maintain existing	40m
ENT 06/04	UG Cable	6+700	Protect and maintain existing	65m
ENT 13/01	UG Cable	13+550	Protect and maintain existing	325m
ENT 13/02	UG Cable	13+700	Diversion required. To be placed in verge	675m
ENT 13/03	UG Cable	13+700	Protect and maintain existing	87m
ENT 13/04	UG Cable	13+950	Protect and maintain existing	45m
ENT 14/01	UG Cable	14+200	Protect and maintain existing	296m
ENT 14/02	UG Cable	14+450	Protect and maintain existing	118m
ENT 15/01	UG Cable	15+050	Diversion required.	289m
ENT 15/02	UG Cable	15+150	Protect and maintain existing	90m
ENT 15/03	UG Cable	15+700	Protect and maintain existing	170m

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
ENT 15/04	UG Cable	15+730	Diversion Required. To be placed in verge	185m
ENT 15/05	UG Cable	15+830	Protect and maintain existing	62m
ENT 15/06	UG Cable	15+880	Diversion Required. To be placed in verge	135m
ENT 15/08	UG Cable	15+920	Protect and maintain existing	483m
ENT 16/01	UG Cable	16+350	Diversion required. To be placed in verge	467m
ENT 16/02	UG Cable	16+600	Protect and maintain existing	412m

9.4.4 Telecommunications Towers

There are a total of 2 conflicts between telecommunications towers and the proposed road development. The first of these communications towers is located between the Cappagh Road and Ballymoneen Road junctions and is operated by Vodafone. It is proposed that this mast will be decommissioned prior to the commencement of construction work. The mast currently has valid planning permission for operation up to the end of 2020. The location at which the conflict occurs between the Vodafone communications tower and the proposed road development is shown in Drawings **GCOB-2700-D-450** to **452** in **Volume 2**.

The second mast that is in conflict with the proposed road development is located in close proximity to Galway Racecourse and is operated by Three Networks Ireland. It is proposed that this mast will be decommissioned prior to the commencement construction work and relocated nearby the existing location. The mast relocation work must be undertaken prior to the decommissioning of the current tower as to minimise disruption to the network. The location at which the conflict occurs between the Three Networks Ireland communications tower and the proposed road development is shown in Drawings **GCOB-2700-D-450** to **452** in **Volume 2**. Also shown is the proposed relocation and necessary works. The locations at which conflicts occur with the communications towers are shown below in **Table 9.9**.

Table 9.9: Locations of Mobile mast conflictions with the proposed N6 GCRR

Ref	Type	Approx. Chainage (m)	Provisional measures
VOD 04/01	Telecommunications Tower	4+650	Decommission existing telecommunications tower if not already decommissioned
THR 14/01	Telecommunications Tower	14+450	Decommission existing telecommunications tower
THR 14/02	Telecommunications Tower	14+700	Construct new communications tower at new location

9.4.5 BT

BT have a number of underground fibre optic cables running in ducting along existing roads within the proposed road development study area. There are a total of 6 conflicts between the BT services and the N6 GCRR, of which only 1 requires a diversion.

The locations at which conflicts occur between BT services and the proposed road development are shown in Drawings **GCOB-2700-D-460** to **467** in **Volume 2**.

Also shown are the proposed diversions and necessary works. The locations at which conflicts occur with the BT services are shown below in **Table 9.10**.

Table 9.10: Locations of BT line conflictions with the proposed N6 GCRR

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
BT 13/01	UG Cable	13+900	Protect and maintain existing	235m
BT 14/01	UG Cable	14+450	Protect and maintain existing	310m
BT 15/01	UG Cable	15+800	Protect and maintain existing	178m
BT 16/01	UG Cable	16+050	Protect and maintain existing	280m
BT 16/02	UG Cable	16+300	Diversion required	495m
BT 16/03	UG Cable	16+550	Protect and maintain existing	375m

9.5 Sanitary & Water Services

Protection, diversion or relocation of sanitary and water services will be made in agreement with the Water Services Department of Galway City Council and with Irish Water. Irish Water are the governing body in relation to foul, combined sewers and watermain services. The surface water sewers fall under the remit of Galway City Council.

9.5.1 Irish Water – Potable Water

Galway City and County Councils in conjunction with Irish Water have potable water infrastructure serving the settlement areas within the proposed road development study area. Properties located in the urban area around Galway City are generally connected to the public watermains however there are also private dwellings within the proposed development boundary that have private wells. As noted above, Irish Water are the governing body in relation to public potable watermains. There are a number of conflicts between Irish Water watermains and the proposed road development, many of which will require diversion works.

The locations at which conflicts occur between Irish Water watermains and the proposed road development are shown in Drawings **GCOB-2700-D-400** to **440** in **Volume 2**. Also shown are the proposed diversions and necessary works. The locations at which conflicts occur with the watermains are shown below in **Table 9.11**.

Table 9.11: Locations of Irish Water watermains conflictions with the proposed N6 GCRR

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
WAT 00/01	150mm Ø	0+000	Protect and maintain existing	100m
WAT 00/02	150mm Ø	0+000	Diversion required	125m
WAT 00/03	150mm Ø	0+000	Protect and maintain existing	50m
WAT 01/01	150mm & 200mm Ø	1+150	Protect and maintain existing. Place in sleeve beneath proposed road crossing	350m
WAT 01/02	80mm Ø	1+570	Protect and maintain existing	90m
WAT 01/03	80mm Ø	1+570	Diversion required	40m
WAT 01/04	80mm Ø	1+570	Protect and maintain existing. Place in sleeve beneath proposed road crossing	90m
WAT 01/05	80mm Ø	1+600	Protect and maintain existing	105m
WAT 02/01	150mm Ø	2+550	Protect and maintain existing. Place in sleeve beneath proposed road crossing	575m
WAT 02/02	100mm Ø	2+750	Protect and maintain existing	115m
WAT 02/03	100mm Ø	2+760	Diversion required	155m
WAT 02/04	100mm Ø	2+760	Protect and maintain existing	140m
WAT 03/01	80mm Ø	3+250	Diversion required	130m
WAT 03/02	150mm Ø	3+350	Protect and maintain existing	70m
WAT 04/01	150mm Ø	4+450	Protect and maintain existing	66m
WAT 04/02	150mm Ø	4+450	Diversion required	107m
WAT 04/03	150mm Ø	4+450	Protect and maintain existing	67m
WAT 05/01	250mm Ø	5+650	Protect and maintain existing	50m
WAT 05/02	250mm Ø	5+650	Diversion required	195m
WAT 06/01	150mm Ø	6+150	Diversion required	100m
WAT 06/02	150mm Ø	6+150	Diversion required	280m
WAT 06/03	250mm Ø	6+280	Diversion required	147m
WAT 06/04	250mm Ø	6+300	Diversion required	180m
WAT 06/05	250mm Ø	6+300	Protect and maintain existing	140m
WAT 06/06	250mm Ø	6+530	Protect and maintain existing	45m
WAT 06/07	150mm Ø	6+200	Diversion required	45m
WAT 06/08	250mm Ø	6+600	Diversion required	97m
WAT 06/09	150mm Ø	6+600	Protect and maintain existing	160m
WAT 06/10	250mm Ø	6+650	Protect and maintain existing	304m
WAT 06/11	250mm Ø	6+650	Protect and maintain existing	217m
WAT 06/12	250mm Ø	6+650	Protect and maintain existing	76m
WAT 06/13	150mm Ø	6+250	Protect and maintain existing	242m

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
WAT 07/01	250mm Ø	7+050	Protect and maintain existing	103m
WAT 07/02	250mm Ø	7+220	Diversion required	275m
WAT 07/03	300mm Ø	7+230	Diversion required	340m
WAT 07/04	150mm Ø	7+250	Diversion required	525m
WAT 07/05	150mm Ø	7+250	Diversion required	80m
WAT 07/06	300mm Ø	7+250	Protect and maintain existing	160m
WAT 07/07	300mm Ø	7+250	Diversion required	50m
WAT 07/08	300mm Ø	7+250	Protect and maintain existing	160m
WAT 07/09	80mm Ø	7+250	Proposed new diversion required	606m
WAT 07/10	80mm Ø	7+900	Protect and maintain existing	26m
WAT 08/01	100mm Ø	8+250	Diversion required	128m
WAT 08/02	100mm Ø	8+300	Diversion required	122m
WAT 08/03	100mm Ø	8+400	Protect and maintain existing	352m
WAT 08/04	25mm Ø	8+400	Diversion required	170m
WAT 08/05	100mm Ø	8+490	Protect and maintain existing	465m
WAT 08/06	100mm Ø	8+520	Diversion required	95m
WAT 11/01	100mm Ø	11+390	Proposed new diversion required.	1062m
WAT 12/01	100mm Ø	12+130	Protect and maintain existing. Place in sleeve beneath proposed road crossing	406m
WAT 12/02	50mm Ø	12+140	Protect and maintain existing. Place in sleeve beneath proposed road crossing	417m
WAT 13/01	100mm Ø	13+100	Protect and maintain existing	85m
WAT 13/02	100mm Ø	13+130	Temporary diversion required initially. Permanent diversion to be placed in bridge deck	305m
WAT 13/03	100mm Ø	13+200	Protect and maintain existing	30m
WAT 13/04	250mm Ø (10 inch)	13+500	Protect and maintain existing	471m
WAT 13/05	500mm Ø	13+510	Protect and maintain existing	474m
WAT 13/06	250mm Ø (10 inch)	13+870	Diversion required	213m
WAT 13/07	500mm Ø	13+880	Diversion required	590m
WAT 13/08	250mm Ø (10 inch)	13+990	Protect and maintain existing	384m
WAT 14/01	380mm Ø (15 inch)	14+150	Protect and maintain existing	106m
WAT 14/02	25mm Ø (1inch)	14+400	Protect and maintain existing	90m
WAT 14/03	100mm Ø	14+950	Protect and maintain existing	80m
WAT 15/01	100mm Ø	15+000	Diversion required	318m

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
WAT 15/02	100mm Ø	15+150	Protect and maintain existing	150m
WAT 15/03	250mm Ø	15+200	Diversion required	97m
WAT 15/04	250mm Ø	15+230	Protect and maintain existing	20m
WAT 15/05	150mm Ø	15+700	Protect and maintain existing	208m
WAT 15/06	200mm Ø	15+900	Protect and maintain existing	80m
WAT 15/07	200mm Ø (8 inch)	15+900	Protect and maintain existing	282m
WAT 16/01	150mm Ø	16+450	Diversion required	123m
WAT 16/02	150mm Ø	16+525	Protect and maintain existing	405m

9.5.2 Irish Water – Foul Network

As noted above, Irish Water are the governing body in relation to public foul and combined sewers. Properties located in the urban area around Galway City are generally connected to the public sewers. In the rural areas the majority of non-agricultural properties utilise septic tanks.

There are a number of conflicts between Irish Water foul and combined sewers and the proposed road development, 5 of which will require diversion works. The locations at which conflicts occur between Irish Water sewers and the proposed road development are shown in Drawings **GCOB-2700-D-310** to **331** in **Volume 2**. Also shown are the proposed diversions and associated works. The locations at which conflicts occur with the sewers are shown below in **Table 9.12**.

Table 9.12: Locations of Irish Water watermains conflictions with the proposed N6 GCRR

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
FOUL 05/01	300mm Ø	5+650	Protect and maintain existing	390m
FOUL 05/02	300mm Ø	5+950	Diversion required	225m
FOUL 06/01	300mm Ø	6+350	Protect and maintain existing	325m
FOUL 06/02	1500mm Ø	6+350	Protect and maintain existing	230m
FOUL 06/03	225mm Ø	6+350	Protect and maintain existing	45m
FOUL 06/04	300mm Ø	6+350	Protect and maintain existing	130m
FOUL 06/05	300mm Ø	6+600	Protect and maintain existing	85m
FOUL 06/06	300mm Ø	6+750	Protect and maintain existing	160m
FOUL 06/07	300mm Ø	6+800	Protect and maintain existing	145m
FOUL 07/01	300mm Ø	7+100	Protect and maintain existing	100m
FOUL 07/02	225mm Ø	7+400	Protect and maintain existing	95m
FOUL 08/01	450mm Ø	8+750	Protect and maintain existing	19m
FOUL 08/02	225mm Ø	8+750	Protect and maintain existing	19m

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
FOUL 11/01	100mm Ø	11+200	Proposed new 100mm diameter rising main connection to Lackagh Tunnel services building and tunnel wash down facility	1685m
FOUL 12/01	450mm Ø	12+220	Protect and maintain existing	395m
FOUL 13/01	225mm Ø	13+285	Protect and maintain existing	25m
FOUL 13/02	225mm Ø	13+285	Temporary diversion required. Foul sewer to be relayed in bridge deck	325m
FOUL 13/03	225mm Ø	13+285	Protect and maintain existing	50m
FOUL 13/04	300mm Ø	13+550	Protect and maintain existing	145m
FOUL 13/05	900mm Ø	13+550	Protect and maintain existing	145m
FOUL 13/06	300mm Ø	13+650	Diversion required	165m
FOUL 13/07	300mm Ø	13+740	Protect and maintain existing	55m
FOUL 13/08	900mm Ø	13+740	Protect and maintain existing	50m
FOUL 13/09	150mm Ø	13+800	Protect and maintain existing	8m
FOUL 13/10	750mm Ø	13+870	Protect and maintain existing	590m
FOUL 14/01	375mm Ø	14+450	Protect and maintain existing	125m
FOUL 14/02	600mm Ø	14+450	Protect and maintain existing	70m
FOUL 14/03	150mm Ø	14+470	Protect and maintain existing	105m
FOUL 15/01	375mm Ø	15+280	Diversion required	199m
FOUL 15/02	225mm Ø	15+800	Protect and maintain existing	38m
FOUL 16/01	225mm Ø	16+570	Protect and maintain existing	275m
FOUL 16/02	225mm Ø	16+500	Diversion required	181m

9.5.3 Galway City Council – Surface Water Network

As noted above, Galway City Council are the governing body responsible for the surface water sewer network within the proposed road development study area.

There are a number of conflicts between the Galway City Council surface water sewers and the proposed road development, 4 of which will require diversion works. The locations at which conflicts occur between Irish Water sewers and the proposed road development are shown in Drawings **GCOB-2700-D-310** to **331** in **Volume 2**. Also shown are the proposed diversions and associated works. The locations at which conflicts occur with the sewers are shown below in **Table 9.13**.

Table 9.13: Locations of Galway City & County Council surface water sewers conflictions with the proposed N6 GCRR

Ref	Type	Approx. Chainage (m)	Provisional measures	Affected Lengths (m)
SW 05/01	300mm Ø	5+650	Protect and maintain existing	390m
SW 05/02	300mm Ø	5+850	Diversion required	223m
SW 06/01	225mm Ø	6+340	Protect and maintain existing	193m
SW 06/02	375mm Ø	6+350	Protect and maintain existing	45m
SW 06/03	300mm Ø	6+350	Protect and maintain existing	30m
SW 06/04	450mm Ø	6+300	Protect and maintain existing	135m
SW 06/05	1500mm Ø	6+600	Protect and maintain existing	84m
SW 06/06	225mm Ø	6+750	Protect and maintain existing	135m
SW 06/07	600mm Ø	6+800	Protect and maintain existing	310m
SW 07/01	1200mm Ø	7+100	Protect and maintain existing	102m
SW 07/02	450mm Ø	7+400	Protect and maintain existing	60m
SW 13/01	900mm Ø	13+650	Diversion required	170m
SW 13/02	300mm Ø	13+800	Protect and maintain existing	10m
SW 15/01	600mm Ø	15+280	Diversion required. Replacement with 750mm pipe	335m
SW 15/02	225mm Ø	15+800	Protect and maintain existing	38m
SW 15/03	225mm Ø	15+800	Protect and maintain existing	38m
SW 15/04	900mm Ø	15+810	Protect and maintain existing	61m
SW 15/05	225mm Ø	15+810	Protect and maintain existing	30m
SW 15/06	225mm Ø	15+860	Protect and maintain existing	39m
SW 16/01	225mm Ø	16+570	Protect and maintain existing	275m
SW 16/02	225mm Ø	16+500	Diversion required	178m

9.6 Summary

For ease of reference table references and associated drawings for each service and utility type are summarised in **Table 9.14** below.

Table 9.14: Utility Tables and Drawing Set References

Service Provider	Table Reference	Drawing Numbers
ESBI	9.1	GCOB-2700-D-280-287
ESB HV	9.2	GCOB-2700-D-290-309
ESB LV	9.3	GCOB-2700-D-360-396
SSE Airtricity	9.4	GCOB-2700-D-350-354
Gas Networks Ireland	9.5	GCOB-2700-D-250-256
Eir	9.6	GCOB-2700-D-200-240
Virgin Media	9.7	GCOB-2700-D-340-346
E-Net	9.8	GCOB-2700-D-260-275
Three Networks Ireland	9.9	GCOB-2700-D-450-452
Vodafone	9.9	GCOB-2700-D-450-452
BT	9.10	GCOB-2700-D-460-467
Irish Water - Watermains	9.11	GCOB-2700-D-400-440
Irish Water – Foul Sewers	9.12	GCOB-2700-D-310-331
Galway City Council – Surface Water Sewers	9.13	GCOB-2700-D-310-331

10 Traffic Signs, Lighting & Communications

10.1 General

Signage will be provided along the proposed road development to ensure that clear directional and regulatory messages are communicated to road users. The design of the signs and road marking will be based on the 2010 Traffic Signs Manual by the Department of Transport, Tourism and Sport 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) by the Department of Transport, Tourism and Sport.

The road lighting design shall meet the requirements of BS5489-1, IS EN 13201 Code of Practice for the design of road lighting, Lighting of roads and public amenity areas and TII Publication DN-LHT-03038 Design of Road Lighting for the Strategic Motorway and All Purpose Trunk Road Network and TII Publication DN-ITS-03037 The Use of Variable Message Signs on All-Purpose & Motorway Roads TII Publications DN-LHT-03078 Design of Road Lighting for All-Purpose Trunk Roads and TII MCDRW Series 1300

Information Communication Technology (ICT) and traffic control shall comply with requirements set in TII MCDRW series 1500.

10.2 Road Signs and Markings Preliminary Design

10.2.1 General

A preliminary Traffic Sign and Road Marking (TSRM) design has been undertaken to identify the requirements of the proposed road development. The preliminary design has been undertaken taking cognisance of the early stage of the project and therefore allows for further adjustments or optimisation of the design at the detailed design phase. A combination of Advance Direction Signs (ADS) and overhead gantry signs have been assessed taking consideration of road user safety, potential land acquisition and construction cost. Where possible, particular care has been afforded to rationalising signage so not to overload road users with an excess of information.

The preliminary assessment primarily involved an assessment of major road traffic signage which includes requirements for all regulatory signs (TSM Chapter 5), warning signs (TSM Chapter 6), and road markings (TSM Chapter 7). The preliminary design also includes the design of the directional information signs (TSM Chapter 2), variable message signs (TSM Chapter 3), and traffic signals (TSM Chapter 9). All major signage support structures have been fully assessed at the preliminary design stage in order to design for the vehicle restraint system (VRS) and the associated land take requirements. VRS considers concrete gantry plinths and signs posts of certain diameter and strength which are located within the clear zone and considered to be a hazard. Passively safe posts will be introduced where possible to eliminate the need for VRS systems.

A preliminary layout of Traffic Signs and Road Markings can be seen in Drawings **GCOB-1200-D-000** to **015** in **Volume 2**.

10.2.2 Gantry Signage

The preliminary design identified the need for 29 directional sign gantries to be located along the mainline dual carriageway. Where possible signage has been rationalised to combine directional signs over single portal gantries spanning either one half of the mainline carriageway, or over the entire mainline carriageway. 21 portal frame gantries have been identified during the preliminary design. Portal frame gantries will also support all proposed Variable Message Signs (VMS). Refer to **Section 10.4** and Drawings **GCOB-1500-D-001** to **015** in **Volume 2** for further information on VMS signage strategy. Eight cantilever gantries are proposed in total, at the entry to the diverge tapers at the N59 Letteragh Junction, and at the R339/R446 grade separated junction at Coolagh. Refer to **Chapter 7, Structures, Section 7.4.2** of this Design Report for further information on gantries. As per the existing N6/M6 at Coolagh, three ADS are required on the grade separated dual carriageway section which will be erected on the verge to minimise the use of gantries.

10.2.3 Sign Colour

Different colours will be assigned to directional signs depending on the statutory designation of the carriageway, as per requirements of the TSM. A green background is proposed to be assigned to signs along the single carriageway from Baile Nua to Ballymoneen Road and also along the mainline dual carriageway from Ballymoneen Road to the N59 Letteragh Junction representing its National Road status. This section will also form part of a Protected Road designation. The Urban Motorway section to the east of the N59 Letteragh grade separated junction will represent a blue background reflecting its motorway status. All other directional signs on regional and local roads will be erected on a white background. It is a statutory requirement that all place names on information signs be in both English and Irish, however one exception to this rule is where the destinations are in Gaeltacht areas, where the names of places are in Irish only. Additionally, on road signage located within the Gaeltacht boundary, for destinations outside of the Gaeltacht, the Irish version of the destination placename will be prioritised.

10.2.4 Road Markings

A preliminary design of road markings has been undertaken across the proposed road development in accordance with TSM Chapter 7. Refer to Drawings **GCOB-1200-D-000** to **015** in **Volume 2** for details. This exercise also involved the preliminary road marking design of the following items:

Bus lanes

Bus lanes will be marked accordingly at the proposed Gort na Bró Junction, the N83 Tuam Road (south bound), and at the Ballybrit Crescent Road (south bound).

Emergency Exits

Overheight vehicle and emergency exits at each of the four tunnel portals have been provided. These exits will be barrier controlled and proposed chevron and diagonal markings will be in yellow to make it clear to the road user that these are not intended to be used as an alternative route.

Cycle Lanes

On-line with flow cycle lanes are provided at various locations across the proposed road development. The pavement will be marked according to best practice guidelines such as DMURS and the National Cycle Manual with particular attention given to junctions. Advance Stacking Locations (ASLs) have been designed where possible to provide a safer passage for cyclists at signal controlled junctions for straight ahead or right turn movements. The N59 Letteragh Junction is designed to allow safe passage for cyclists diverging from the eastbound carriageway and for cyclists merging west bound to the dual carriageway section. With flow cycle lanes are provided at and between the Letteragh Road Junction and the Rahoon Road Junction, the City North Business Park Link Road, Parkmore Link Road, Ballybrit Crescent Road and Monivea Road.

Pedestrian Crossings

Pedestrian crossings varying from 2.4m and 3.2m in width (multiples of the $0.8m^2$ tactile pavement) have been incorporated throughout the design with footpaths provided. The larger pedestrian crossing width was allocated to areas that are expected to accommodate a relatively high number of non-motorised users. DMURS classifies pedestrian crossing widths in areas of low to moderate pedestrian activity as 2.5m and areas of moderate to high pedestrian activity as 3m.

10.3 Road Lighting

The road lighting design along the route of the proposed road development shall meet the requirements of BS5489-1, IS EN 13201 and DN-LHT-03038 and DN-LHT-03078. A preliminary design of the road lighting for the proposed road development is shown on Drawings **GCOB-1300-D-000** to **015** contained in **Volume 2**.

It is proposed to provide public lighting at both roundabouts on the proposed road development for reasons of safety. Lighting shall be provided for the grade separated N59 Letteragh Junction, the N84 Headford Road Junction, the N83 Tuam Road Junction, the Coolagh Junction and associated slip roads in accordance with TII Guidelines. Lighting will also be provided at the entrance to both Lackagh Tunnel and Galway Racecourse Tunnel.

It is also proposed to light the mainline alignment between the N84 and N83 junctions due to high volumes of traffic, number of lanes and weave merge traffic movements in this location.

The City North Business Park Link, Parkmore Link Road and N59 Link Road North and South are also proposed to be lit as they are considered to be urban roads with facilities provided for non-motorised users.

Where facilities for non-motorised users e.g. public footpath and cycle tracks are provided beneath the mainline alignment in an underbridge, wall mounted public lighting will be provided beneath the structure.

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 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 this beyond what would be the current status quo. These generally include:

- The use of LED lanterns with well-defined and controlled light beam distributions. When compared with traditional discharge lamps and lantern technologies, this will provide a significant reduction in light trespass to surrounding areas and properties
- These lanterns are applied to columns with a maximum height of 10m. In areas less sensitive to light trespass, 12m – 15m columns would be more typical for a road lighting installation of this scale. The lower column height ensures that stray light is minimised further
- The lanterns are mounted on bracket arms with a 0° degree 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. The output of this is evident within Drawings **GCOB-1300-D-000** to **015** contained in **Volume 2**.

10.4 Communications

This section of the report describes the proposed Intelligent Transport Systems (ITS) that will be included in the proposed road development. It is subdivided in to two distinct preliminary design sections:

i. Mainline ITS Communication and Traffic Control Systems
ii. Tunnel ITS Communication and Traffic Control Systems

It is envisaged that the technology utilised will offer future flexibility, particularly with use of open standard protocols commonly used throughout Ireland and the UK. The exact operational setup and responsibility matrix will be defined in advance of progressing to the detailed design phase. The proposed communication systems for the proposed road development are outlined on Drawings **GCOB-1500-D-001** to **015** in **Volume 2**.

10.4.1 Mainline – ITS Communications and Traffic Control Systems

10.4.1.1 General Description

An outline description is provided below for the ITS Communications and Traffic Control systems for the proposed road development. For the purpose of the mainline communications and traffic control systems the design area commences at the dual carriageway section at Ballymoneen Road Ch. 5+650 in the west and extends eastwards to the N6 tie in at Coolagh.

The immediate approach roads to the Lackagh and Galway Racecourse tunnels are also included in the description, but the tunnels themselves are dealt with in **Section 10.4.2**.

The design of the mainline ITS systems should take cognisance of the tunnel ITS systems as described in **Section 10.4.2**.

10.4.1.2 Design Criteria

The design methodology utilised for the preliminary design is based on (and shall adhere to) the following documents:

- TII Publications CC-SPW-01500 Specification for Traffic Control and Communications
- TII Publications CC-GSW-01500 Guidance on Specification for Traffic Control and Communications
- TII Intelligent Transport Systems (ITS) National Strategy (2015-2025)

10.4.1.3 Traffic Management

To facilitate the traffic management of the proposed road development, a number of systems are proposed which will enable the road operator to monitor and control for multiple operational scenarios.

These systems are essential to:

- Dissemination of information to drivers i.e. suggested diversion routes, advance warning of incidents
- Real-time monitor and control of road traffic and traffic flow
- React to incidences in near real time and minimise disruption to traffic

The systems proposed to facilitate the tunnel traffic management are as follows:

- Automatic Incident Detection

- Closed Circuit Television (CCTV)
- Variable Speed Limits/Lane Control Signals
- Variable Message Signs (VMS)
- Journey Time System
- Support Systems

10.4.1.4 Automatic Incident Detection

The proposed road development shall include an Automatic Incident Detection (AID) system. The purpose of the AID is to allow the road operator to monitor live traffic status and to be automatically alerted to queuing traffic, slow moving traffic and stopped vehicles. For the purpose of this preliminary design it is assumed that this requirement will be facilitated through the use of induction loops installed at a frequency as set out in the TII Publications CC-SPW-01500.

As a minimum, the induction loops and associated Traffic Management Units (TMU) and roadside cabinets shall be installed at a frequency no more than 500m.

Depending on the confidence in the technology when carrying out the detailed design, the induction loops may be replaced by radars or via CCTV video analytics for the purpose of AID.

10.4.1.5 CCTV

The proposed road development shall be equipped with Closed Circuit Television (CCTV) at strategic locations throughout the scheme. The CCTV system is essential for road operations, enabling the road operator to visually monitor the road status in real time and enabling informed decisions to be made. The CCTV systems also allows the road operator to verify alarms, that may be identified by the respective traffic control (i.e. the AID systems), and other reported incidents from operational staff or 3rd parties.

The CCTV cameras are envisaged to be Pan, Tilt, Zoom type (PTZ), allowing the road operator to adjust viewing angles to cover the proposed road development. The CCTV system is envisaged to provide full coverage on the mainline dual carriageway sections, at junction locations and VMS/ITS Gantry locations to enable VMS displays to be verified by the road operator.

The CCTV may also support other road monitoring functions such as AID. This functionality may be enabled by sophisticated video analytic techniques that are now becoming available.

10.4.1.6 Variable Message Signs

Throughout the proposed road development Variable Message Signs (VMS) shall be strategically located to provide the road operator with an essential tool for dissemination of information to drivers.

The VMS will be of TII MS3 type, located in advance of junctions and at key decision points, presenting an opportunity for the road operator to suggest alternative routes where available. The TII MS3 are a common type of VMS sign utilised on the TII network, and is a full LED matrix sign, of similar dimension to the Highways England 3 x 18 MS3 type sign.

At some locations, it may be necessary to provide the MS3 type VMS on portal gantries to accommodate Advanced Directional signage.

In addition to providing the road operator with a mechanism to disseminate advisory information to drivers, the VMS can also be used to display estimated journey time information as captured through a ANPR system and TII Journey Time Management System as described in the below section.

The VMS are envisaged to be controlled via the TII Motorway Traffic Control Centre (MTCC) and the respective TII Advanced Traffic Management System (ATMS). The MTCC currently manages the TII national roads and motorway ITS systems and is located within the Dublin Tunnel Control Building.

Co-ordination and the sharing of VMS control on the immediate approach to the Lackagh and Galway Racecourse tunnels may be required depending on operational responsibilities and requirements to facilitate a more holistic approach to traffic management on the TII road network.

10.4.1.7 Journey Time System

Across the proposed road development, a Journey Time System will also be installed. This consists of strategically located Automatic Number Plate Recognition (ANPR) cameras. The ANPR are utilised to capture the number plates of passing vehicles. This number plate data is then sent to the MTTC Journey Time Estimation System which can then be used to display journey times on the VMS described in **Section 2.3.3** above.

ANPR cameras will be installed on all MS3 VMS installed on the scheme. In addition to this, there are other proposed standalone sites at strategic locations. The placement of these sites will support full coverage for journey time recording.

10.4.1.8 System Support Infrastructure

It is envisaged that an optical fibre network shall be installed throughout the proposed road development. The purpose of the optical fibre network will be to provide a high bandwidth, secure and resilient connectivity between ITS Roadside equipment and the MTCC.

In addition to the fibre network, the additional infrastructure required to facilitate the TII ITS systems include the following (but not limited to):

- ITS Roadside cabinets
- Mains power connectivity (i.e. feeder pillars, power strips)
- Optical Distribution Frames (ODF’s)

- Access and distribution switches
- UPS

10.4.1.9 Ducting and Chamber Network

To facilitate the TII ITS infrastructure and future requirement, a comprehensive duct and chamber network will be installed throughout the proposed road development. The specification shall meet the requirements of the TII DMRB, and consist of the following continuous network of ducts along either side of the mainline and side roads:

- 2 x 100mm ITS Power Ducts
- 4 x 100mm ITS Communications Ducts

The ducting network shall be accessible via type ‘A’ and ‘B’ chambers located throughout the duct network as per the TII DMRB.

Typically, this will consist of chambers located at no greater than 250m intervals, with additional chambers to facilitate access to equipment, cable pulling, manoeuvring around obstacles, bridges and crossings.

In addition, a transverse duct road crossing shall be located at least every 500m throughout the N6 Galway City Ring Road mainline and side roads.

The scheme shall also include a separate continuous network of 2 x 100mm ducts throughout the scheme, designated solely for the Department of Communications. The Department of Communications ducting shall be a standalone network with independent chamber access.

Drawings **GCOB-D-1500-000** to **015** in **Volume 2** show the extent of the communications ducting and chambers.

10.4.1.10 Telephone System

Emergency Roadside Telephones (ERT) shall be installed throughout the proposed road development mainline enabling drivers/users to initiate and participate in audio communications directly with the road operator (i.e. the MTCC) in the event of an accident/breakdown.

The ERT locations and specification shall be as per the requirements of the TII DMRB and be interoperable with the existing TII ERT Installations.

Typically, the ERTs will be located at intervals no greater than 2km, and between junction merges and diverge slip roads. Additional ERT will also be located as required to discourage ERT users from crossing a carriageway to access an ERT.

10.4.1.11 Traffic Monitoring

The TII ITS systems described in **Section 10.4.1** above shall be interoperable with and managed by the existing TII ITS systems, as operated by the TII MTTC from the Dublin Tunnel Control Building. This will include the use of open protocols such as UTMC and NTCIP as advised and determined by the TII MTCC system developers and maintainers.

To facilitate communications between each of the ITS Roadside equipment and MTTC, a mixture of communications systems shall be utilised as appropriate including an optical fibre network, mobile communications and leased line.

10.4.2 Tunnel – ITS Communications and Traffic Control Systems

10.4.2.1 General Description

An outline description is provided below on the ITS Communications and Traffic Control systems proposed for inclusion within both the Lackagh and Galway Racecourse Tunnels. The preliminary design outlined below incorporates the traffic control and communications systems both within the tunnels and their immediate approaches.

The high level requirements for each of the tunnels are identical, and hence the below requirements are applicable for both tunnels with the relative location of equipment adjusted for the respective tunnel and tunnel approach road alignments.

The design of the tunnel ITS systems should take cognisance of the mainline ITS systems as described in **Section 10.4.1**.

10.4.2.2 Design Criteria

The design methodology utilised for the preliminary design is based on (and shall adhere to) the following documents:

- TII Publications DN-STR-03015 Design of Road Tunnels
- Directive 2004-54-EC on Minimum Safety Requirements for Tunnels in the trans-European road network

In addition to the above, where applicable, existing Irish tunnel design practices have been incorporated so as to promote general consistency and driver familiarity between tunnels across the Irish road network.

Note that while DN-STR-03015 provides some guidance on what systems should be incorporated in a tunnel of this type, the extent and complexity of these systems are subject to the consultation and approval of the Tunnel Design and Safety Consultation Group (TDSCG).

10.4.2.3 Traffic Management

To facilitate the traffic management of the tunnel, a number of systems are proposed which will enable a tunnel operator to monitor and control the tunnel operations for various operational scenarios.

These systems are essential for:

- Closing a tunnel bore/lane in the event of an incident (or to prevent incident)
- Closing the tunnel bore/lane to facilitate maintenance
- Reducing/varying the speed limit within the tunnel
- Dealing with Over-Height Vehicles

The systems proposed to facilitate the tunnel traffic management are as follows:

- Automatic Incident Detection
- Closed Circuit Television (CCTV)
- Variable Speed Limits/Lane Control Signals
- Over-height Detection
- Barriers for lane closures
- Traffic Signals
- Variable Message Signs (VMS)
- Support Systems

10.4.2.4 Automatic Incident Detection

The tunnel shall include an Automatic Incident Detection (AID) system. The purpose of the AID is to allow the tunnel operator to monitor live traffic status and be automatically alerted to traffic queuing, slow moving traffic and stopped vehicles. For the purpose of this preliminary design this requirement will be facilitated through the use of induction loops installed on the road surface at a minimum spacing of 50m on each lane throughout the tunnel, in addition to the exit/entrance of each lane/bore. On the immediate approach to the tunnel, AID will also be installed but at a spacing frequency of 500m.

Depending on the confidence in the technology and proven use within a tunnel environment, when carrying out the detailed design the induction loops may be replaced by radars or via the use CCTV video analytics for the purpose of AID.

10.4.2.5 CCTV

The proposed tunnel and tunnel approach shall be equipped with Closed Circuit Television (CCTV). The CCTV system is essential for tunnel operations, enabling the tunnel operator to visually monitor the tunnel status in real time and make informed decisions. The CCTV systems will also allow the tunnel operator to verify any alarms that may be identified by the respective traffic control or SCADA/fire systems.

The CCTV cameras are envisaged to be Pan, Tilt, Zoom type (PTZ), allowing the tunnel operator to adjust viewing angles to cover all aspects of the tunnel. The CCTV system is envisaged to provide full coverage throughout the tunnel and approaches and as a minimum will be located as follows:

- CCTV cameras will be installed every 50m within the tunnel, including coverage of the tunnel SOS phones, laybys and the pedestrian crossover points
- To facilitate remote monitoring of the following:
  - Entrance to the tunnel bores
  - Exit of the tunnel bores
  - Over-height detection locations
  - Over-height detection pull-in locations/barrier for over-height vehicle escape
  - Emergency Roadside Telephone (ERT) on approach to tunnel
  - Any Variable Message Signage (VMS) / Lane Control Signals (LCS), traffic signals on approach to the tunnel

The detailed design of the CCTV may also support other tunnel system functions such as Automatic Incident Detection (AID) and automatic fire detection. This functionality may be enabled by sophisticated video analytic techniques that are now becoming available.

10.4.2.6 Lane Control Signals/Variable Speed Limits

The tunnel shall be equipped with Lane Control Signals (LCS) both within and on approach to the tunnel and over-height exit points. The LCS provide the following functions:

- Enable Variable Speed Limits to be implemented
  - This provides the operator with the facility to slow down traffic in the interest of safety or smoothing traffic flow
- Enable individual lanes to be closed
  - This provides the operator with the facility to close lanes within the tunnel in the event of an incident, or to facilitate maintenance
  - This provide the operator with the facility to close lanes and stop over-height traffic before they reach the tunnel

The location of the LCS are envisaged to be located as follows:

- Above each lane at the entrance to the tunnel bore
- Above each lane, every 50m throughout each tunnel bore
- Above each lane on the tunnel approach (i.e. final 500m) at three locations

Additional LCS would also be placed in advance of over-height exist points to allow the removal of over-height vehicle form the roadway.

On the tunnel approach, the LCS shall be located on portal ITS gantries and accompanied by one TII MS4 type Variable Message Sign (VMS) to enable additional information to be disseminated to the driver. Depending on the location of the ITS Gantry, the gantry may also support Advanced Directional Signage.

Note, all LCS proposed for this project are single sided and are not designed to facilitate contra flow. If contra flow was to be incorporated in to the design, additional LCS would be required to cover the reverse direction in each bore. A revised alignment, VMS, barriers, signals etc. would also be required. Following consultation with the TDSCG, it was decided that contra flow will not be proposed in either of the tunnels on the proposed road development as there are alternative routes available with minimal diversion lengths in the event of a tunnel closure.

10.4.2.7 Over-height Detection

Key to the operational success of the tunnel is to ensure that appropriate systems and procedures are in place to manage over-height vehicles. An over-height vehicle entering a tunnel poses a significant risk to the tunnel operations, infrastructure and general health/road safety.

To protect the tunnel against such risk, an 'Over-Height Vehicle Detection' system shall be utilised. The system has three main functions; the detection of the violating vehicle, providing effective communications to the driver to encourage diversion to an alternative route and safely closing the tunnel to prevent the over-height from entering.

On detection of an over-height vehicle, the violating vehicle driver will be prompted to take an alternative route via the use of VMS. Both the Over-Height Vehicle Detection system and VMS will be located at strategic locations in advance of the tunnel providing the driver with ample opportunity to take an alternative route.

The system will also utilise Automatic Number Plate Recognition (ANPR) cameras to assist in providing a targeted message to the violating driver by making reference to the vehicles registration plate on the VMS display.

In the event that the over-height vehicle ignores all visual warnings provided by the VMS and triggers the next Over-Height Vehicle Detector, the system will automatically initiate a safe tunnel shutdown procedure utilising the LCS, VMS, traffic signals and barriers at tunnel entrance to prevent the over-height vehicle from entering. The operator will be able to verify the existence of an over-height vehicle at the respective locations via the use of CCTV.

In the event of a closure advisory messages will be displayed to all drivers through the use of the VMS both at the tunnel entrance and in advance, so as to keep all drivers informed of the tunnel status. In the vicinity of the exit there will be an escape road with access controlled by a barrier and monitored and controlled by the tunnel operator. The escape road diverts the over-height vehicle to an alternative route away from the tunnel.

The operator shall be able to monitor the over-height vehicle and barrier via a CCTV camera and communicate with the driver via an Emergency Roadside Telephone strategically located at the escape barrier.

Once the over-height vehicle is dealt with, the operator can initiate the re-opening of the tunnel to continue normal operations.

10.4.2.8 Barriers

As referred to in the above sections, there are two barrier types proposed for the scheme, namely:

- Barrier at escape road routes to cater for Over-Height Vehicles
- Barrier at each tunnel entrance

Each of the above barriers will be remotely controlled by the tunnel operator, with the tunnel barrier system being designed to automatically engage preprogramed shutdown scenarios in the event of certain incidents (i.e. fire, queuing traffic, vehicle incident etc.) The tunnel operator will also have the facility to override and directly control the barriers as required and can verify their status via CCTV. The barriers will also have the facility to be manually opened and closed and be locked in place by maintenance and operational staff as required.

10.4.2.9 Traffic Signals

A three aspect traffic signals (Green, Amber, Red) will be provided either side of the carriageway at each tunnel entrance. The function of the traffic signal is to indicate the status of the tunnel bore with the red aspect indicating that the tunnel is closed and the green aspect indicating the tunnel is open.

Signals will also be placed at each of the over-height exit points. These will again be three aspect traffic signals (Green, Amber, Red) and will be provided either side of the carriageway.

The function of the traffic signal at this location is to indicate the status of the carriageway ahead with the red aspect indicating that the carriageway is closed and the green aspect indicating its open.

These messages will be reinforced by the status of the LCS, barriers and the display on the entrance VMS.

10.4.2.10 Variable Message Signs

As referred to in the above sections there are a number of VMS to be located on the approach to the tunnels. The VMS are strategically located and provide the tunnel operator with an essential tool for dissemination of information to drivers. These VMS also provide functionality for mainline operations by strategically locating them.

The VMS envisaged to form part of this tunnel design are as follows:

- One VMS (TII MS4 type) at each Tunnel entrance
- One VMS (TII MS3 type) downstream of each Over-Height Vehicle Detection location
- One VMS (TII MS4 type) on each ITS portal gantry (i.e. min 3no. TII MS4 type VMS in advance of each tunnel entrance)

- One VMS (TII MS3 type) located at approximately 1km in advance of the tunnel entrance

The VMS are envisaged to be controlled via the tunnel traffic control system and preprogramed for various tunnel operational scenarios. Alternatively, the tunnel operator can apply free text to the VMS to suit the particular status of the tunnel with TII approval.

In addition to the above the tunnel operator is also envisaged to have the facility to utilise other strategically located VMS across the road network to facilitate a more holistic approach to traffic management on the TII road network.

10.4.2.11 System Support Infrastructure

To facilitate the traffic control systems described in this section it is envisaged that an optical fibre network shall be installed throughout each tunnel bore and on the approaches. The purpose of the optical fibre network will be to provide secure and resilient connectivity between each of the tunnel systems roadside infrastructure and the main tunnel control systems.

The Information and Communication Technology (ICT) infrastructure to support the tunnel systems (i.e. servers, leased lines, equipment racks, switches, UPS) are envisaged to be housed with the tunnel service buildings located in the vicinity of each tunnel.

10.4.2.12 Telephone System

The tunnel bores will be equipped with SOS phones installed throughout each tunnel bore and will enable drivers/users to initiate and participate in audio communications directly with the tunnel operator in the event of an accident/breakdown.

The SOS phones will be located at 50m intervals throughout the tunnel and at each tunnel entrance and exit. In addition, SOS phones will be installed at the escape road barrier location/over-height vehicle exit points, to facilitate communications from the tunnel operator to the driver of the over-height vehicle.

10.4.2.13 Emergency Procedures

The traffic control systems will provide the tunnel operator with the facility to monitor and control vehicular access to the tunnel via technologies such as the VMS, LCS, traffic signals and barriers. These can be utilised by the tunnel operator to initiate various emergency tunnel operational procedures in the event of an emergency and incident (i.e. accident, pedestrian within tunnel, fire etc.).

10.4.2.14 Traffic Monitoring

As part of the tunnel design it is envisaged that the monitoring and control of the tunnel traffic operations shall be carried out remotely by a tunnel operator. The tunnel operator will have full access to the tunnel traffic detection systems and CCTV both in the tunnel and on its approaches. This will enable the operator to make informed decisions throughout a variety of tunnel operational scenarios. It is envisaged that the tunnel operator will be located at the Dublin Tunnel Control Building and will have full access to the tunnel systems.

In addition to the remote monitoring functionality it is also envisaged that the tunnel control building will have a work console/station that will enable a tunnel operator to take full control of the tunnel and CCTV systems in the event of a communications network issue to the Dublin Tunnel Control Building.

10.5 Summary

A preliminary Traffic Sign and Road Marking (TSRM) design has been undertaken to identify the requirements of the proposed road development. Signage will be provided along the proposed road development to ensure that clear directional and regulatory messages are transmitted to road users. A combination of Advance Direction Signs (ADS) and overhead gantry signs have been designed taking consideration of road user safety, potential land acquisition and construction cost. Road markings for cycle and bus lanes, pedestrian crossings and emergency exit lanes have been included in the preliminary design. The design of the signs and road marking will be compliant with the relevant standards as set out in the Traffic Signs Manual 2010 and associated documents. A preliminary road lighting design has been undertaken to meet the requirements of BS5489-1, IS EN 13201 and DN-LHT-03038.

A preliminary design of Information Communication Technology (ICT) and traffic control has been undertaken on both the mainline and tunnel structures in compliance with requirements set in TII Publications CC-SPW-01500.

11 Accommodation Works & Land Use

11.1 Introduction

This section outlines the design of the proposed accommodation works for the proposed road development.

Galway County Council, together with Arup, undertook a series of meetings with directly affected property owners.

The findings of these meetings have been combined with land registry records to produce a comprehensive landownership mosaic for the proposed road development. Refer to Drawings **GCOB-2700-D-100** to **115** in **Volume 2** for further details.

The landownership mosaic was used to establish access requirements and to evaluate side road and mainline realignments as part of the design phase. Requests made by the property owners and the general public were evaluated and included in the design where they were deemed reasonable and possible in order to provide mitigation measures for the proposed road development.

The land use along the proposed road development comprises a mix of agricultural land, residential clusters, villages and commercial properties. The various land uses are described in the sections below. The extent of the impact due to the proposed road development on a property owner's holding will be shown on the Protected Road Scheme Deposit Maps and Motorway Scheme Deposit Maps.

11.2 Land Use

The total area that lies within the proposed road development boundary is approximately 280ha. Within this area, the footprint of the proposed works extends to approximately 180ha.

11.2.1 Agriculture

195 agricultural land parcels are directly affected by the proposed road development. **Table 11.1** below compares land use along the route of the proposed road development to the statistics for County Galway and nationally. 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 the land holdings 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 11.1: 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**

11.2.2 Non Agricultural

The following is a description of the non-agricultural land use. It is broken down into five sections namely

1. R336 to Ballymoneen Road – Ch. 0+000 to Ch. 5+600
2. Ballymoneen Road to River Corrib Crossing – Ch. 5+600 to Ch. 9+300
3. River Corrib Crossing to N84 Headford Road – Ch. 9+300 to Ch. 12+150
4. N84 Headford Road to N83 Tuam Road – Ch. 12+150 to Ch. 14+000
5. N83 Tuam Road to existing N6, Coolagh – Ch. 14+000 to Ch. 17+450

11.2.2.1 R336 to Ballymoneen Road – Ch. 0+000 to Ch. 5+600

The proposed road development commences on the R336 in Baile Nua less than 2km west of Bearna Village and proceeds north and east as a single carriageway to the north of Bearna Village and onwards towards Letteragh. This area is predominantly agricultural with sporadic one off rural housing. There are few commercial properties within this area. The building pattern of existing homes is ribbon development like along the rural boíthrins. The proposed road development will pass through the townlands and communities 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. There are dwellings directly impacted along this section of the proposed road development. In addition, there is a crèche located on the Cappagh Road to the north of the proposed road development.

The area becomes more built up as the proposed road development proceeds east towards the Ballymoneen Road. There is a large residential development to the east of the proposed road development on Ballymoneen Road in the townland of Ballyburke and an existing planning permission for a large residential development within this townland.

11.2.2.2 Ballymoneen Road to River Corrib Crossing – Ch. 5+600 to Ch. 9+300

Proceeding east toward Letteragh Road the lands to the north of the proposed road development are agricultural compared to the residential area to the south which is closer to Galway City Centre. The lands between Ch. 5+850 and Ch. 6+060 are zoned as residential however there are no valid planning permissions on these lands. There are also a number of residential zoned and serviced lands along the Letteragh Road. Some of these lands have historic planning applications which have been granted or previously refused. Most of the planning applications in this area include large residential developments. At the southern end of Rahoon Road is the Gateway Retail Park and Galway West Business Park. There is a current 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 towards the River Corrib it enters a more urban and residential area. St. James' National School is immediately to the south of the proposed road development in Bushypark, with Glenlo Abbey Golf Course, Kelehans Pub and Bushypark Church located to the north. The area in the townland of Dangan is dominated by National University of Ireland Galway (NUIG) Sporting Campus 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. This facility is also a public amenity as it is used by many other sports clubs within Galway. The area of Dangan is served by the N59 Moycullen Road, which is a main route into Galway City from the northwest of the country. Along the N59 Moycullen Road the residential development is ribbon like either side of the road. The banks of the River Corrib and the River Corrib itself are a significant recreational area serving the population of Galway.

11.2.2.3 River Corrib Crossing to N84 Headford Road – Ch. 9+300 to Ch. 12+150

On the eastern bank of the River Corrib sits Menlo Castle which is located in the townland of Menlough. 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) before emerging in Lackagh Quarry. The lands east of the River Corrib are rural with sporadic one off housing.

To the east of Lackagh Quarry the proposed road development proceeds east to the N84 Headford Road and passes through the communities and townlands of Ballinfoyle and Ballindooley. Between these two communities, individual dwellings line either side of the road. There is a garage, scrapyard and plant hire business to the south of the proposed road development along the N84 Headford Road and a company which source and bottle water and is a distribution centre on the eastern side.

11.2.2.4 N84 Headford Road to N83 Tuam Road – Ch. 12+150 to Ch. 14+000

From the N84 Headford Road the proposed road development proceeds eastwards crossing the townland of Castlegar. 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.

11.2.2.5 N83 Tuam Road to existing N6, Coolagh – Ch. 14+000 to Ch. 17+450

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 builders supplier’s. East of the N83 Tuam Road 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 Summer Festival, occurring annually for a week commencing on the last Monday of July. This is a major event for the city of Galway. There are a number of commercial and industrial areas and individual dwellings in this area also.

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 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, to the south of Coolagh Village. Coolagh, Briarhill 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.

11.3 Accommodation Works

The landownership mosaic, as shown in **GCOB-2700-D-100** to **115** in **Volume 2**, with the recorded consultation data collected from the directly affected property owners has been used to establish access requirements and to evaluate side road and mainline realignments. At this stage some of the requests made by the impacted property owners and the general public have been evaluated and included where it was deemed reasonable and possible in order to provide mitigation measures for the proposed road development.

The accommodation works proposed have been introduced to serve the property owners in the following ways:

- To ensure property owners are given appropriate access to their property and land parcels
- To ensure property owners 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 maintain access to land severed by the proposed road development. These access roads in general are 4.0m wide with 1.0m grass verges on either side and in compliance with TII Publications standard construction detail drawings CC-SCD-02754 and CC-SCD-00706-03. In some cases they shall be ramped, with a maximum gradient appropriate to their intended use. Where access roads are serving more than one house or business, 2 x 3m lane width is provided to accommodate two-way traffic with a 1m wide verge either side. Private driveways to homes shall have a maximum gradient of 10% in accordance with Recommendations for Site Development Works for Housing Areas, Dept of the Environment and Local Government, 1998.

Final details of the access roads and their drainage requirements will be agreed between the affected property owners and Galway County Council during the accommodation works negotiations.

An economic analysis was carried out on a case by case basis by the design team with input from the project agronomist, valuer, and TII for the provision of accommodation underpasses, overbridges and access roads to severed lands. In some instances it was more economical to purchase the severed land rather than provide the accommodation access. As a result, there are no accommodation overbridges or underpasses included as part of the accommodation works for the N6 GCRR scheme.

11.3.1 Access Roads

The details of the proposed access roads and the landowner parties they serve across the proposed road development are shown in **Table 11.2** below.

Table 11.2: Access Roads

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	**Description**		
Ch. 0+000	80m access road AR 0/01 Width 6m	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 AR 0/02 Width 4m	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 AR 0/03 Width 4m	-	Provides access to attenuation ponds
Ch. 0+850 to Ch. 0+950	160m access road AR 0/04 Width 4m	114, 117	Provides access to land parcels
Ch. 0+990	30m access road AR 0/05 Width 4m	-	Provides access to attenuation ponds
Ch. 1+100 (Troscaigh Road L5387)	35m access road AR 1/01 Width 4m	130, 131, 7891	Re-graded entrance to houses 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 AR 1/03 Width 4m	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 AR 1/04 Width 4m	156, 157	Proposed access to tie-in to existing access to houses, and existing property currently accessing off existing access track. Current access arrangement via Troscaigh Road L5387 is impacted by the proposed road development
Ch. 1+550	25m access road AR 1/05 Width 4m	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 AR 1/06 Width 6m	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 AR 2/02 Width 4m	168, 171, 147, 174, 173, 172, 170, 169, 167, 166, 146, 165,	Provides multiple accesses 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 AR 2/01 Width 4m	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 AR 3/01 Width 4m	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 AR 3/02 Width 4m	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 AR 4/01 Width 4m	-	Provides access to attenuation ponds
Ch. 4+240 to Ch. 4+360	140m access road AR 4/02 Width 4m	-	Provides access to attenuation ponds
Ch. 4+450 (South of Cappagh Road Junction)	20m access road AR 4/03 Width 4m	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 AR 4/04 Width 4m	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 AR 4/05 Width 4m	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 AR 4/06 Width 4m	223, 224, 226,	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		
		227	
Ch. 4+950 to Ch. 4+990	60m access road AR 04/07 Width 4m	-	Provide access from mainline to attenuation ponds. Pond access gate to be provided adjacent to the carriageway
Ch. 5+360 to Ch. 5+660 North of Ballymoneen Road Junction	345m access road AR 05/01 Width 6m	223,230, 261	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 AR 05/02 Width 4m	232	Existing accesses to houses are 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 AR 06/01 Width 4m	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 AR 06/02 Width 6m	312, 260	Provides access to farmyard. Access provided as part of Clybaun Road re-alignment
Ch. 6+600 to Ch. 6+960	370m access road AR 06/03 Width 4m	241, 239, 247	Provide access to land parcels as being severed by the proposed road development
Gort na Bró road	100m Gateway Retail Park Link Road AR 06/04 Width 7m	-	Realignment of access to Gateway Retail Park Link Road including roundabout
Gort na Bró road	30m access road AR 06/05 Width 6m	-	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	25m access road AR 06/06 Width 6m	-	Provides access to Gateway Retail Park
N59 Link Road South Ch. 1+900	50m access road AR 07/01 Width 6m	481	Provides access to land parcels as part of the proposed road development
N59 Link Road South Ch. 1+900	60m access road AR 07/02 Width 6m	-	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 AR 07/03 Width 6m	-	Provides access to Bun a' Chnoc and Culgharraí housing developments as part of the proposed road development. Ties-in to AR7/02

Location		**Plot ID / Landowner Reference**	**Comments**
Approx. Chainage	**Description**		
Ch. 7+225 to Ch. 7+300	60m access road AR 07/04 Width 4m	250/466	Located just off Letteragh Road L1323. Provides access to land parcel as current access is severed by the proposed road development
Ch. 7+260 to Ch. 7+450	200m access road AR 07/05 Width 4m	272/462	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 AR 07/06 Width 4m	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 AR 07/07 Width 4m	486, 272/462	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 AR 07/08 Width 4m	457	Provides access to agricultural lands as current access is severed by proposed road development and acquired severed lands
N59 Link Road Ch. 0+700 to Ch. 0+860	210m access road AR 07/09 Width 4m	457, 502, 505, 501, 468	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 AR 07/10 Width 4m	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 AR 07/11 Width 6m	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 AR 08/01 Width 6m	-	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 AR 08/02 Width 4m	515, 522	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 AR 08/03 Width 6m	531, 533, 534, 532 & Retained homes	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 to existing homes.

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
Ch. 8+450	30m access road AR 08/04 Width 6m	-	Located just off the N59 (northern part of the proposed road development). Ties-in to existing Ballagh Road.
Ch. 8+500	640m access road AR 08/05 Width 4m	489	Provides access to attenuation ponds and unhindered access along it to 489
Ch. 9+090 to Ch. 9+160	110m access road AR 09/01 Width 4m	528, 543 557	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 AR 09/02 Width 6m	559, 553, 545, 551, 562, 552, 565, 560, 598, 585, 7039	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 AR 09/03 & AR 09/04
Ch. 9+560 to Ch. 9+710	145m access road AR 09/03 Width 4m	-	Provides access to attenuation ponds. Accessed from AR9/02
Ch. 9+710 to Ch. 9+850	160m access road AR 09/04 Width 4m	500	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 AR 09/05 Width 4m	648	Provides access to land parcel as current access is severed by the proposed road development
Ch. 9+500	120m access road AR 09/06 Width 4m	649	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 AR 10/01 Width 4m	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 AR 10/02 Width 4m	581, 572	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 AR 10/03 Width 4m	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 & AR10/07

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
Ch. 10+625 to Ch. 10+670	65m access road AR 10/04 Width 4m	553	Provides access to land. Ties-in to AR 10/03 & AR10/05
Ch. 10+625 to Ch. 10+725	125m access road AR 10/05 Width 4m	-	Ties-in to AR 10/02 and AR 10/03. Loop around attenuation pond and land access.
Ch. 10+825	20m access road AR 10/06 Width 5m	-	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 is a U-turn accessed from AR10/02
Ch. 10+620 to Ch. 10+700	70m access road AR 10/07 Width 4m	-	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 AR 11/01 Width 4m	583	Provides re-routing for Over Height Vehicles engaged on the N6 GCRR prior entering the Lackagh Tunnel when travelling west-bound. Also provides access to attenuation ponds, and Tunnel services building
Ch. 11+990 to Ch. 12+125	245m access road AR 11/02 Width 4m	583, 603, 8231	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 AR 12/01 Width 6m	602/698/699 /704	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 AR 12/03 Width 4m	602/698/699 /704	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 AR 12/04 Width 4m	626, 627, 627.02	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 AR 13/01 Width 4m		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 AR 13/02 Width 4m	705, 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 AR 13/03 Width 4m	705, 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

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
City North Business Park Link	145m access road AR 13/04 Width 6m	-	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 AR 13/05 Width 4m	-	Provides access to attenuation ponds
Ch. 13+825 to Ch. 14+175 (Off the N83 Tuam Road)	470m access road AR 13/06 Width 6m	682, 681, 680, 679, 678, 677, 676, 675, 674, 673, 658,	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
Parkmore Link Road	50m access road AR 13/07 Width 6m	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 AR 13/08 Varies to tie to existing	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 AR 13/09 Width 6m	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 AR 14/04 Width 4m	701	Provides access to land parcel as current access is severed by the proposed road development
Parkmore Link Road	45m access road AR 14/05 Width 7m	-	Connects the proposed Parkmore Link Road with the existing Parkmore Industrial Estate internal road
Parkmore Link Road	75m access road AR 14/07 Varies to tie to existing	691	Provides access to Galway Racecourse
Parkmore Link Road	20m access road AR14/08 Width 6m	691	Provides access to Galway Racecourse (Taxi Entrance)
Ch. 14+790 to Ch. 15+000	235m access road AR 14/09	-	Provides the last exit point for Over Height Vehicles travelling east-bound on the proposed

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
	Width 4m		road development before to enter the Galway Racecourse Tunnel. Connects to AR15/01
Ch. 15+125	470m access road AR 15/01 Width 6m	-	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, new relocated ESB substation and new relocated telecommunication mast. Ties-in to AR14/09 but also AR 15/06
Ch. 15+200 to Ch. 15+725	545m access road AR 15/02 Width 6m	691, 716, 701, 718, 719, 710	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 AR 15/03 Width 6m	-	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 under S15/02 bridge. Provides access to AR15/04 and to AR15/02
Ch. 15+690 to Ch. 15+720	30 m access road AR 15/04 Width 6m	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 AR 15/05 Width 7m	729, 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 AR 15/06 Width 6m	-	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 AR 15/07 Width 4m	-	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 AR 16/01 Width 6m	724	Provides access to land parcel as current access is severed by the proposed road development and to attenuation ponds
Ch. 16+800 to Ch. 16+830	30m access road AR 16/02 Width 4m	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 AR 17/01 Width 4m	754, 751, 752	Provides access to land parcels as current access is severed by the proposed road development. Connects to existing access road

11.3.2 Access Gates and Entrances

The details of the proposed access gates and entrances and the landowner parties they serve across the proposed road development are shown in **Table 11.3** below.

Table 11.3: Access Gates and Entrances

Location		**Plot ID / Landowner Reference**	**Comments**
Approx. Chainage	**Description**		
0+000	Retain existing gate	101	Agricultural land
0+000	Agricultural access gate	102	Agricultural land
0+000	Agricultural access gate	103	Agricultural land
0+050	Agricultural access gate	106	Agricultural land
0+100	Agricultural access gate	107	Agricultural land
0+150	Agricultural access gate	108	Agricultural land
0+200	Agricultural access gate	109	Agricultural land
0+250	Agricultural access gate	112	Agricultural land
0+650, 0+700, 0+850	Agricultural access gate	117	Agricultural land
0+850	Agricultural access gate	114	Agricultural land
1+100	Residential entrance	126	Residential property
1+100	Residential entrance	125	Residential property
1+100	Residential entrance	125	Machinery Shed
1+150	Residential entrance	130	Residential property
1+150	Residential entrance	131	Residential property
1+150	Agricultural access gate	7891	Agricultural land
1+300	Agricultural access gate	144	Agricultural land
1+300, 1+300	Agricultural access gate	145	Agricultural land
1+300	Agricultural access gate	146	Agricultural land
1+350	Agricultural access gate	156	Agricultural land
1+600	Agricultural access gate	149	Residential access
1+600	Residential entrance	150	Residential property
1+600	Residential entrance	151	Residential property
1+600	Residential entrance	152	Residential property
1+600	Agricultural access gate	154	Agricultural land
1+600	Residential entrance	155	Residential property
1+600	Residential entrance	157	Residential property
1+600	Residential entrance	158	Residential property
1+600	Residential entrance	159	Residential property
1+600	Agricultural access gate	160	Agricultural land
1+600	Residential entrance	162	Residential property
1+600	Residential entrance	163	Residential property

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
1+700	Agricultural access gate	153	Agricultural land
1+750	Agricultural access gate	165	Agricultural land
1+800	Agricultural access gate	146	Agricultural land
1+850	Agricultural access gate	166	Agricultural land
1+900	Agricultural access gate	167	Agricultural land
1+930	Agricultural access gate	169	Agricultural land
1+970	Agricultural access gate	170	Agricultural land
2+000	Agricultural access gate	171	Agricultural land
2+050	Agricultural access gate	172	Agricultural land
2+100	Agricultural access gate	171	Agricultural land
2+150	Agricultural access gate	173	Agricultural land
2+170	Agricultural access gate	174	Agricultural land
2+250	Agricultural access gate	147	Agricultural land
2+300	Agricultural access gate	171	Agricultural land
2+450	Agricultural access gate	168	Agricultural land
2+500	Agricultural access gate	165	Agricultural land
2+550	Agricultural access gate	176	Agricultural land
2+750	Residential entrance	195	Residential property
2+800	Agricultural access gate	193	Agricultural land
3+250	Agricultural access gate	199	Rural Fringe
3+300	Agricultural access gate	198	Agricultural land
3+300	Residential entrance	207	Residential property
3+300	Residential entrance	202	Residential property
3+350	Residential entrance	206	Residential property
3+400	Agricultural access gate	197	Agricultural land
3+500	Agricultural access gate	205	Agricultural land
3+600	Agricultural access gate	208	Agricultural land
3+700	Agricultural access gate	209	Agricultural land
3+850	Agricultural access gate	210	Agricultural land
4+450	Agricultural access gate	213	Agricultural land
4+450	Residential entrance	220	Residential property
4+450	Residential entrance	222	Residential property
4+450	Residential entrance	221	Residential property
4+450	Residential entrance	217	Residential property
4+450	Residential entrance	218	Residential property
4+450	Residential entrance	219	Residential property
4+450	Residential entrance	215	Residential property

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
4+520	Agricultural access gate	216	Agricultural land & Residential Property
4+550	Agricultural access gate	223	Agricultural land
4+650, 4+650	Agricultural access gate	226	Agricultural land
4+550	Agricultural access gate	223	Agricultural land
4+620	Agricultural access gate	224	Agricultural land
4+650	Agricultural access gate	227	Agricultural land
4+700	Agricultural access gate	223	Agricultural land
5+350	Agricultural access gate	223	Current agricultural land. Zoned Rec Amenity
5+500	Agricultural access gate	261	Current agricultural land. Zoned Residential
5+600	Agricultural access gate	230	Current agricultural land. Zoned Residential
5+650	Agricultural access gate	261	Current agricultural land. Zoned Residential
5+650	Agricultural access gate	229	Current agricultural land. Zoned Residential
5+700	Agricultural access gate	229	Current agricultural land. Zoned Residential
5+700	Residential entrance	234	Residential property
5+650	Residential entrance	232	Residential property
5+650	Residential entrance	232	Residential property
6+350	Agricultural access gate	242	Current agricultural land. Zoned Residential
6+350	Agricultural access gate	241	Agricultural land
6+500	Agricultural access gate	312	Agricultural land
6+400	Agricultural access gate	241	Agricultural land
6+410	Agricultural access gate	243	Agricultural land
6+400	Agricultural access gate	312	Agricultural land
6+550	Agricultural access gate	312	Agricultural land
6+550	Agricultural access gate	243	Agricultural land
6+600	Agricultural access gate	243	Agricultural land
6+650	Agricultural access gate	241	Agricultural land
6+700	Retain existing residential entrance	244	Residential property
6+750	Agricultural access gate	239	Agricultural land
6+950	Agricultural access gate	247	Agricultural land
7+250	Residential entrance	463	Residential property
7+250	Agricultural access gate	483	Current agricultural land. Zoned Residential

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
7+250	Agricultural access gate	484	Current agricultural land. Zoned Residential
7+250	Agricultural access gate	484	Current agricultural land. Zoned Residential
7+250	Agricultural access gate	484	Current agricultural land. Zoned Residential
7+250	Agricultural access gate	258	Current agricultural land. Zoned Residential
7+250	Residential entrance	486	Residential property
7+250	Agricultural access gate	258	Current agricultural land.
7+250	Agricultural access gate	272/462	Agricultural land
7+250	Residential entrance	272/462	Residential property
7+250	Agricultural access gate	272/462	Agricultural land
7+250	Residential entrance	255	Residential property
7+250	Agricultural access gate	257	Agricultural land, zoned residential
7+250	Access Road	481	Zoned Industrial
7+250	Residential entrance	298	Residential property
7+250	Agricultural access gate	251	Agricultural land
7+250	Agricultural access gate	254	Agricultural land
7+250	Residential entrance	252	Residential property
7+250	Agricultural access gate	273/461	Agricultural land
7+250	Agricultural access gate	251	Agricultural land
7+250	Agricultural access gate	250	Agricultural land
7+250	Agricultural access gate	273/461	Agricultural land
7+250	Agricultural access gate	313	Agricultural land
7+250	Agricultural access gate	249	Agricultural land
7+250	Residential entrance	296	Residential property
7+250	Residential entrance	296	Residential property
7+250	Agricultural access gate	258/464	Agricultural land
7+300	Agricultural access gate	272/462	Agricultural land
7+500	Agricultural access gate	272/462	Agricultural land
7+500	Agricultural access gate	272/462	Agricultural land
7+600	Residential entrance	457	Residential property acquired, not demolished
7+600	Agricultural access gate	457	Agricultural land severed and acquired
7+600	Agricultural access gate	457	Agricultural land
Gort na Bró Link Road 0+150	2 no access gates	452	Zoned Lands

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	**Description**		
7+600	Agricultural access gate	501	Agricultural land
7+650	Agricultural access gate	501, 468	Agricultural land (2 No. Agricultural Gates)
7+750	Agricultural access gate	502	Agricultural land
7+750	Agricultural access gate	505	Agricultural land
7+900	Agricultural access gate	506	Agricultural land
7+900	Agricultural access gate	504	Agricultural land
8+400	Residential entrance	515	Residential property
8+400	Agricultural access gate	522	Light Residential.
8+440	Residential entrance	518	Residential property acquired, not demolished
8+450	Agricultural access gate	495	Agricultural land
8+450	Agricultural access gate	496	Current agricultural land. Zoned Residential
8+450	Residential entrance	496	Residential property
8+450	Retain existing residential entrance	523	Residential property
8+450	Agricultural access gate	526	Light Residential / Rec Amenity.
8+560	Residential entrance	533	Residential property
9+550	Agricultural access gate	648	Agri Amenity
9+650	Agricultural access gate	560	Agri Amenity
9+700	Agricultural access gate	559	Agricultural land
9+720	Agricultural access gate	553	Agricultural land
10+050	Agricultural access gate	566	Agricultural land
10+050	Agricultural access gate	564	Agricultural land
10+100	Agricultural access gate	563	Agricultural land
10+100	Agricultural access gate	565	Agricultural land
10+100	Agricultural access gate	554	Agricultural land
10+100	Agricultural access gate	554	Agricultural land
10+100	Residential entrance	569	Residential property
10+450	Agricultural access gate	573	Agricultural land
10+500	Agricultural access gate	571	Agricultural land
10+500	Residential entrance	577	Residential property
10+500	Residential entrance	576	Residential property
10+500	Agricultural access gate	579	Agricultural land
10+610	Agricultural access gate	563, 572	Agricultural land (2 No. Agricultural Gates)
10+670	Agricultural access gate	553	Agricultural land

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
10+850	Agricultural access gate	591	Agricultural land
10+900	Agricultural access gate	581	Agricultural land
12+000	Agricultural access gate	603	Agricultural land
12+150	Commercial entrance	602	Commercial property
12+100	Agricultural access gate	606	Agricultural, Agri. Amenity.
12+100	Residential entrance	607	Residential property
12+100	Residential entrance	700	Residential property
12+100	Residential entrance	608	Residential property
12+100	Residential entrance	620	Residential property
12+100	Residential entrance	620	Residential property
12+100	Agricultural access gate	586	Current agricultural land. Zoned Residential
12+550	Agricultural access gate	626	Agricultural land
12+790	Agricultural access gate	627	Agricultural land
13+130	Agricultural access gate	635	Agricultural land
13+130	Residential entrance	637	Residential property, acquired, not demolished
13+130	Residential entrance	637	Residential property, acquired, not demolished
13+150	Residential entrance	631	Residential property, acquired, not demolished
13+200	Agricultural access gate	627	Agricultural land
13+200	Agricultural access gate	651	Agricultural land
13+270	Agricultural access gate	705	Agricultural land
13+400	Agricultural access gate	705	Agricultural land
13+420	Agricultural access gate	658	Agricultural land
13+500	Residential entrance	666	Residential property
13+500	Residential entrance	666	Residential property
13+500	Agricultural access gate	662	Current agricultural land. Zoned Residential
13+500	Residential entrance	663	Residential property
13+550	Residential entrance	669	Residential property
13+600	Agricultural access gate	661	Current agricultural land. Zoned Residential
13+840	Agricultural access gate	658	Agricultural
14+100	Access Road	673	Commercial
14+100	Residential entrance	674	Residential property
14+150	Agricultural access gate	688	Current agricultural land. Zoned Residential

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	Description		
14+150	Agricultural access gate	664	Current agricultural land. Zoned Residential
14+150	Agricultural access gate	688	Current agricultural land. Zoned Residential
14+150	Agricultural access gate	688	Current agricultural land. Zoned Residential
14+150	Agricultural access gate	689	Current agricultural land. Zoned Residential
14+150	Commercial entrance	690	Light industrial and commercial
14+150	Residential entrance	667	Residential property
14+150	Residential entrance	682	Residential property
14+150	Retain existing residential entrance	683	Residential property
14+400	Agricultural access gate	694	Current agricultural land. Zoned Industrial
14+400	Commercial entrance	695	Industrial
14+400	Commercial entrance	695	Industrial
14+400	Agricultural access gate	693	Current agricultural land. Zoned Industrial
14+400	Agricultural access gate	694	Current agricultural land. Zoned Industrial
14+400	Agricultural access gate	694	Current agricultural land. Zoned Industrial
14+400	Recreational/Commercial entrance	691	Current Recreational/Commercial land. Zoned Industrial
14+400	Recreational/Commercial entrance	691	Current Recreational/Commercial land. Zoned Industrial
14+420	Agricultural access gate	701	Current agricultural land. Zoned Industrial
15+200	Agricultural access gate	716	Current agricultural land. Zoned Industrial, access from parking to graveyard
15+500	Agricultural access gate	716	Current agricultural land. Zoned Industrial
15+600	Agricultural access gate	701	Current agricultural land. Zoned Industrial
15+650	Agricultural access gate	718	Current agricultural land. Zoned Industrial
15+700	Agricultural access gate	719	Current agricultural land. Zoned Industrial
15+700	Commercial entrance	720	Commercial property
15+720	Agricultural access gate	719	Agricultural

Location		Plot ID / Landowner Reference	Comments
Approx. Chainage	**Description**		
15+800	Farmyard entrance	719	Farmyard
15+850	Farmyard entrance	719	Farmyard
15+900	Agricultural access gate	714	Current agricultural land.
15+900	Agricultural access gate	714	Current agricultural land.
16+100	Commercial entrance	724	Current agricultural land. Zoned LAP
16+250	Agricultural access gate	126	Current agricultural land. Zoned LAP
16+850	Agricultural access gate	756	Current agricultural land. Zoned LAP
16+950	Agricultural access gate	754	Current agricultural land. Zoned LAP
17+120	Agricultural access gate	751	Current agricultural land. Zoned LAP
17+400	Agricultural access gate	752	Current agricultural land. Zoned LAP

11.3.3 Boundary Treatment

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.

Fence types will vary across the proposed road development depending on different circumstances which may require, timber post and rail fencing, mammal proof timber post and railfencing with mesh, masonry walls, steel palisade fencing, noise barriers, parapets and may be temporary in nature. Fencing and boundary walls in accordance with TII Publications will be used. Circa 25.5km of dry stone wall will be removed as part of the proposed road development.

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 and Turlough (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.

Mammal proof fencing details in accordance with TII standards is to be provided where specified. Note any permanent or temporary fencing that is to be installed outside of the mammal proof fenceline shall ensure a 200mm high gap from ground level to the bottom of a tension mesh, to ensure free passage of mammals and direct towards the appropriate mammal underpasses.

Refer also to Drawings **GCOB-300-D-000** to **015** in **Volume 2** for further information on Fencing and Environmental Barriers.

11.4 Demolitions and Acquisitions

11.4.1 General

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.

These properties are listed below in **Table 11.4** and **Table 11.5** and are also shown in Figures 14.1 to 14.15 and Figures 15.3.01 to 15.3.15 of the EIAR.

11.4.2 Demolition Methodology

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. The method statement will outline how the contractor proposes to undertake the demolition works in accordance with the Construction Environmental Management Plan (CEMP) in order to demonstrate that the work will be carried out safely and to ensure that significant environmental impacts will not arise. The contractor will ensure to put in place a Quality Assurance Plan to ensure correct structures are demolished. This method statement will be approved by the Employer in advance of any works.

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.

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 Chapter 7, Construction Activities of the EIAR.

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 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 to 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 soft 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.

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.

11.4.3 Demolition Waste Generation

Demolition materials will be generated as a result of site clearance works and from the demolition of buildings and other structures currently in existence along the route of the proposed road development.

It is estimated that 44 residential properties, five industrial units and two commercial buildings and 17 farm parcels with agricultural structures along with plant buildings in Lackagh Quarry will be demolished as part of the proposed road development.

Tables 11.4 and **11.5** below includes a register of properties to be demolished.

Published waste demolition data was used to estimate demolition waste from residential properties. Of the 44 residential properties for demolition 20 have an estimated floor area of 275m^2 and 24 have an estimated floor area of 120m^2 floor area. An estimated 8,473 tonnes of waste would therefore be generated from demolition of residential properties.

Approximately 10,990m^2 floor area of commercial properties will be demolished as part of the proposed road development. An estimated 39,000 tonnes of waste would be generated from demolition of commercial properties.

A large portion of demolition waste is expected to be inert waste such as concrete, brick and glass. Metals and timber waste would also be generated from demolition. Where separation of plastics, steel, cabling etc. from inert waste is not possible this is classified as non- hazardous waste.

An asbestos audit will be carried out on buildings prior to demolition. Any asbestos encountered will be removed in accordance with the relevant legislation and disposed by specialist Contractors to an appropriately licensed facility.

Table 11.4: Agricultural Properties to be Demolished

Protected Road Scheme / Motorway Scheme Number	Townland	Description	Description of Landtake
117	Barna	Agricultural Land / Farm	small shed / outhouse
154	Barna	Agricultural Land / Farm	small farm yard
208	Ballard	Agricultural Land / Farm	Shed/Outhouse
229	Ballyburke	Agricultural Land / Farm	small farm yard
239	Mincloon	Agricultural Land / Farm	farm yard
243	Mincloon	Agricultural Land / Farm	old shed / outhouse

Protected Road Scheme / Motorway Scheme Number	Townland	Description	Description of Landtake
259	Letteragh	Agricultural Land / Farm	small shed / outhouse
457	Barnacranny	Agricultural Land / Farm	Farm yard
495	Ballagh	Agricultural Land / Farm	Shed / outhouse
498	Ballagh	Agricultural Land / Farm	small shed / outhouse
572	Menlo	Agricultural Land / Farm	small shed / outhouse
583	Menlo	Quarry/ Agricultural Usage	Sheds/outhouses
625	Castlegar	Agricultural Land / Farm	small farm yard
626	Castlegar	Agricultural Land / Farm	small shed and yard
632	Castlegar	Agricultural Land / Farm	old shed / outhouse
689	Parkmore	Agricultural Land/Farm	small shed / outhouse
691	Ballybrit	Agricultural Land / Farm	Galway Racecourse - stables
701	Ballybrit	Agricultural Land / Farm	stable & farm yard
754	Doughiska	Agricultural Land / Farm	silage pit

Table 11.5: Residential, Commercial or Industrial Properties to be Fully Acquired or Demolished

Protected Road Scheme / Motorway Scheme Number	Townland	Description	Area of Property (Ha)	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
121	Na Foraí Maola Thiar	House and garden	1.081	Demolition of house and garden	1.081
122	Na Foraí Maola Thiar	House and garden	0.385	Demolition of house and garden	0.385
123	Na Foraí Maola Thiar	House and garden	0.223	Acquisition of house and garden	0.223

Protected Road Scheme / Motorway Scheme Number	Townland	Description	Area of Property (Ha)	Description of Landtake	Land to be Acquired (ha)
133	Na Foraí Maola Thoir	House and garden	0.307	Demolition of house and garden	0.307
124	Na Foraí Maola Thiar	Full residential planning permission *	0.470	Acquisition of whole site	0.470
157	Na Foraí Maola Thoir	House and garden	0.383	Acquisition of house and garden	0.383
154	Troscaigh Thiar	House and garden	2.383	Demolition of house, buildings and garden	1.804
203	Cloghscoltia	House and garden	0.403	Acquisition of house and garden	0.403
206	Ballard East	House and garden	0.206	Acquisition of house and garden	0.206
230	Keeraun	House and garden and surrounding lands	10.486	Demolition of house and garden and partial landtake	2.093
253	Letteragh	House and garden	0.142	Demolition of house and garden	0.142
457	Barnacranny	House and garden	5.539	Demolition of house and garden	4.057
457	Barnacranny	House and garden	5.539	Acquisition of houses and garden	4.057
497	Ballagh	House and garden	0.436	Demolition of house and garden	0.436
498	Ballagh	House and garden	2.681	Acquisition of house and garden	1.183
518	Dangan Upper	House and garden	0.304	Acquisition of house and garden	0.304
520	Dangan Upper	House and garden	0.274	Demolition of house and garden	0.274

Protected Road Scheme / Motorway Scheme Number	Townland	Description	Area of Property (Ha)	Description of Landtake	Land to be Acquired (ha)
519	Dangan Upper	House and garden	0.259	Demolition of house and garden	0.259
530	Dangan Lower	House and garden	0.281	Demolition of house and garden	0.281
537	Dangan Lower	House and garden	0.353	Demolition of house and garden	0.353
538	Dangan Lower	House and garden	0.329	Demolition of house and garden	0.329
539	Dangan Lower	House and garden	0.308	Demolition of house and garden	0.308
540	Dangan Lower	House and garden	0.372	Demolition of house and garden	0.372
532	Dangan Lower	House and garden	0.251	Acquisition of house and garden	0.251
567	Menlough	House and garden	0.425	Demolition of house and garden	0.425
568	Menlough	House and garden	0.424	Demolition of house and garden	0.424
583	Coolough	Quarry	20.913	Acquisition of whole site	20.760
610	Ballindooley	House and garden	0.085	Demolition of house and garden	0.085
614	Ballindooley	House and garden	0.119	Demolition of house and garden	0.119
613	Ballindooley	House and garden	0.192	Demolition of house and garden	0.192
657	Ballindooley	House and garden	0.158	Demolition of house and garden	0.158
615	Ballindooley	House and garden	0.131	Demolition of house and garden	0.131

Protected Road Scheme / Motorway Scheme Number	Townland	Description	Area of Property (Ha)	Description of Landtake	Land to be Acquired (ha)
621	Ballindooley	House and garden	0.312	Demolition of house and garden	0.312
612	Ballindooley	House and garden	0.075	Demolition of house and garden	0.075
601	Ballindooley	House and garden	1.049	Demolition of house and garden	1.049
609	Ballindooley	House and garden	0.079	Demolition of house and garden	0.079
616	Ballindooley	House and garden	0.174	Demolition of house and garden	0.174
617	Ballindooley	House and garden	0.048	Demolition of house and garden	0.048
619	Castlegar	House and garden	0.099	Demolition of house and garden	0.099
611	Ballindooley	House and garden	0.226	Demolition of house and garden	0.226
618	Castlegar	House and garden	0.075	Demolition of house and garden	0.075
636/637	Castlegar	House and garden	0.195	Acquisition of house and garden	0.195
633	Castlegar	House and garden	0.351	Demolition of house and garden	0.351
652	Castlegar	House and garden	0.170	Demolition of house and garden	0.170
643	Castlegar	House and garden	0.124	Demolition of house and garden	0.124
644	Castlegar	House and garden	0.120	Demolition of house and garden	0.120
642	Castlegar	House and garden	0.193	Demolition of house and garden	0.193

Protected Road Scheme / Motorway Scheme Number	Townland	Description	Area of Property (Ha)	Description of Landtake	Land to be Acquired (ha)
631	Castlegar	House and garden	6.810	Acquisition of house and garden	00.763
658	Castlegar	House and garden	16.914	Demolition of house and garden	1.669
632	Castlegar	House and garden **	2.224	Demolition of house and garden	2.224
673	Cappanabornia	Builders Providers - warehouse and yard	1.316	Demolition of buildings & partial landtake	0.768
671	Cappanabornia	House and garden	2.833	Demolition of house and garden	2.833
672	Cappanabornia	House and garden	0.151	Demolition of house and garden	0.151
713	Ballybrit	Builders Suppliers	1.106	Demolition	1.106
708	Ballybrit	Industrial - unfinished build	1.140	Demolition of 4 buildings	1.140
711	Ballybrit	Industrial - unfinished build	0.259	Demolition	0.259
701	Ballybrit	House and garden	5.972	Demolition of house and garden	4.246
725	Doughiska / Coolagh	House and garden	0.213	Demolition of house and garden	0.213
724	Doughiska / Coolagh	Two houses and garden	4.074	Demolition of 2 houses and garden	2.717

Note:

** at the time of writing sites have valid planning permission*

11.5 Planning Permission Impacts

The proposed road development will require the acquisition of lands from five properties upon which currently full planning permission has been granted 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 11.6**.

Table 11.6: Non-Agricultural Planning Permissions affected by the proposed road development

Protected Road Scheme / Motorway Scheme Number	Townland	Description of Planning Application	Area of Property (Ha)	Description of Landtake/ Modification	Land to be Acquired (ha)
124	Na Foraí Maola	House and garden	0.47	Acquisition of full property	0.47
149	Troscaigh Thiar	Planning permission for roadside boundary wall and existing access point as constructed with all associated works and ancillary services	0.200	Boundary Wall relocation, Road Bed acquisition	0.0075
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. (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 flood lighting. (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

12 Permanent Maintenance Facilities

12.1 Description of Facility

There are two proposed permanent maintenance facilities as part of the proposed road development. 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. Refer to Drawings contained in **Volume 2: GCOB-2700-D-1000** & **GCOB-2700-D-1001** and **GCOB-3000-D-200** to **GCOB-3000-D-216**.

12.1.1 Tunnel Operations Building

The tunnel services, monitoring and maintenance buildings (TSB) will be located at two locations as described above. The TSB may include office areas, 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.

The TSB will house operations personal and tunnel plant and equipment. Electrical services will be provided to the TSB including all power distribution, standby generators, lighting, life safety and communications requirements.

Heating, ventilation and air conditioning will be required to the TSB. In particular, the TER(s) containing all of the control and communicating equipment will be provided with duty and standby close control air conditioning systems.

Public health systems to the tunnel service building will include mains, cold and hot water supplies, and foul drainage to all sinks and sanitary ware.

Firefighting equipment to the service building will include portable first aid fire extinguishers. The TER(s) will be fitted with automatic gaseous fire suppression systems to protect the equipment within.

The duty and standby hydrant pumps (if required) for the tunnel hydrant system shall be located in the TSB. The water storage required shall be located externally immediately adjacent to the hydrant pump room.

It is generally anticipated that plant rooms shall be naturally ventilated.

Where temperatures within plant rooms cannot be contained within tenable conditions, wall mounted axial fans will be provided behind louvres to assist natural ventilation air flow rates. Electrical heaters shall be provided to ensure that all plant rooms are maintained above 4°C.

12.2 Access and Traffic

The main access for Lackagh Quarry TSB will be from the existing main entrance of Lackagh Quarry on Coolough Road.

There is an emergency access road off the N6 GCRR on the westbound carriageway in advance of the eastern tunnel portal which will also provide access from the mainline in emergency situations. This access road runs south through Lackagh Quarry adjacent to the TSB building and to the entrance/exit of the Lackagh Quarry on Coolough Road. 16 car parking spaces have been provided on site with direct access off the proposed Lackagh Quarry access road.

The main access to the Racecourse Tunnel TSB will be from the realigned Racecourse Avenue. There is also access provided from the mainline via an emergency exit ramp on the approach to the western tunnel portal which surfaces at grade adjacent to the TSB site. 30 car parking spaces have been provided on site with direct access off the realigned Racecourse Avenue. A separate entrance for service vehicles to the rear is also provided.

Adequate sightlines and turning circles are provided for light and heavy goods maintenance vehicles accessing to and from the service yard areas located adjacent to the proposed tunnel service buildings.

12.3 Surface Water Drainage

The surface water drainage design has been carried out for the proposed access road to the Tunnel Service Building at Lackagh Quarry in accordance with DN-DRA-03022.

The surface water drainage design for the Lackagh TSB site compound is 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 site is to ground via an infiltration basin which is provided as part of the mainline road drainage system. Refer to Drawing **GCOB-500-D-115** in **Volume 2**.

A surface water drainage network is provided along the realigned Racecourse Avenue which provides access to the Racecourse TSB. The fully sealed drainage system on the realigned Racecourse Avenue comprises of a kerb and gully and sealed carrier drain system.

The surface water drainage design for the Racecourse Tunnel TSB site compound is 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 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. Refer to Drawings **GCOB-500-D-119** and **GCOB-500-D-120** in **Volume 2** for further details.

12.4 Potable Water Supply

Water connections are required for both TSBs for potable water usage. The water demand 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. Refer to Drawing **GCOB-2700-D-426** in **Volume 2**. Details of Design Volumes are provided in **Section 12.6.2.2**.

Pre-Connection Enquiries have been submitted to Irish Water for the proposed water connections required for the TSBs and approval has been obtained and a copy of the approvals are provided in **Appendix A.8.7**.

12.5 Foul Water Drainage

A pre connection enquiry form has been approved in principle by Irish Water for the connection to the existing public foul sewers. 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 same rising main is being utilised for the foul discharge from the Lackagh Tunnel drainage network. Refer to Drawings **GCOB-500-D-115** and **GCOB-500-D-132** in **Volume 2** for further details.

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. A separate rising main will be utilised for the foul discharge to the same foul sewer from the Galway Tunnel drainage network. Refer to Drawings **GCOB-500-D-119** and **GCOB-500-D-120** in **Volume 2** for further details. Details of Design Volumes are provided in **Section 12.3.2.2**.

Pre-Connection Enquiries have been submitted to Irish Water for the proposed foul connections required for the TSBs and approval has been obtained and a copy of the approvals are provided in **Appendix A.8.7**.

12.6 Services and Utilities

12.6.1 Ventilation

It is anticipated that the office and reception areas shall be naturally ventilated by means of openable windows. The TER's will be provided with mechanical ventilation to slightly pressurise the room. The plantrooms shall be naturally ventilated by means of louvres located in walls or doors. A dedicated toilet extract system shall be provided to all washroom and changing facilities. The design of HVAC systems shall be in accordance with CIBSE recommendations.

12.6.1.1 Pollution and Vehicle Emission

If deemed required at detailed design stage that pollution levels in the vicinity of the tunnel dictate, the supply air systems to the TSB facility shall be provided with charcoal filters to deal with emissions from vehicles.

12.6.1.2 Fresh air Requirements

Fresh air requirements shall be in line with the recommendations for CIBSE. In general where mechanical ventilation is provided it shall be sized to deliver a minimum of 10l/s per person based on normal expected occupancy.

12.6.1.3 Monitoring and Control

The HVAC systems shall be provided with a digital control system to allow users control temperature set points and plant running times within set limits. Frost protection will be provided to automatically start up HVAC to maintain minimum internal temperatures.

12.6.2 M&E Elements of Drainage in the TSB

Foul drainage from sinks and sanitary ware in the buildings shall be collected by means of a single pipe ventilated system. The foul drainage shall discharge by gravity to the IDA foul sewer at the Galway Racecourse TSB and via a pumped rising main from the Lackagh TSB to the local authority foul main. Refer to **Section 12.5** for further details.

Storm water from roof and canopy areas shall be collected and shall discharge by gravity to the IDA trunk surface water sewer at the Galway Racecourse TSB and by infiltration at the Lackagh TSB. Refer to **Section 12.3** for further details.

12.6.2.1 Design Criteria

Above ground foul drainage and storm water systems shall be in accordance with IS EN 12056 and the Irish Building Regulations 2010 Part H Drainage and Waste Water Disposal.

12.6.2.2 Design Volumes

The predicted volumes of foul water from, and potable water to, the tunnel service buildings are designed in accordance with EPA Wastewater Treatment Manuals, Treatment Systems for Small Communities, Business, Leisure Centres and Hotels. The design wastewater loading is 60 litres per person per day which is in accordance with Table 3 of the above guidance document.

The storm water system for the roof of building will be designed in accordance with BS EN 12056 Sanitary and Rainwater Drainage Design.

12.6.2.3 Pumping Equipment

It is anticipated that drainage from the racecourse service building shall be by gravity and no pumping equipment is required.

A proposed pump station and associated rising main is located at the Western Portal of the Lackagh Tunnel, this is provided to discharge water from the Lackagh tunnel. This pump station will also handle foul flows from the tunnel services building. This pump station is discussed further in **Chapter 8, Drainage, Hydrology & Flood Risk** of this Report.

12.6.3 Electrical Services in the TSB

12.6.3.1 Electrical Supply

It is expected that ESB Networks (ESBN) will provide an MV supply to each building. This will be rated at 10kV initially with a possible future increase to 20kV.

An ESBN MV substation will be required at each TSB building.

12.6.3.2 Electrical Distribution System

The electrical distribution system will be configured with two independent, diverse, active distribution paths (denoted A & B) serving equipment in the TSB and the tunnel. Both A & B systems will be fully live and operational at all times.

Distribution will be via distribution boards and cables.

12.6.3.3 MV Switchgear

An incoming MV switchboard will be provided.

MV switchgear will be free-standing, air insulated, metal-clad type complying with EN 62271-200. MV breakers will be vacuum insulated and withdrawable.

12.6.3.4 Transformers

Two MV/LV step-down transformers will be provided. They will be dry type cast resin and will be low loss with an efficiency class of AoAk in accordance with EN 50541.

They will have dual 20kV and 10kV primary windings and 400V secondary winding.

Both will be rated to be capable of supporting the full load of the facility.

12.6.3.5 LV Generator

A standby diesel generator will be provided. Output voltage will be 400V.

The generator will be rated to be capable of supporting the full load of the TSB and tunnel without load shedding.

Generator power rating category will be Prime Power i.e. capable of delivering continuous power while supplying a variable electrical load for an unlimited number of hours per year. It will comply with transient response performance class G2 as defined in ISO 8528-1-7.

The generator will have an integral base fuel tank with capacity to allow the generator to run for 12 hours on full load. A separate double skin bulk fuel tank will be installed in an external bunded area with capacity to allow the generator to run at full load for 48 hours. A fuel washing system will be installed.

A loadbank will be provided to allow the generator to be fully load tested regularly.

There will also be a facility to connect a generator to the switchgear via power lock connectors. This will allow a temporary mobile generator to be connected if the generator is out of operation for a period.

Generator operation will be controlled automatically from the Power Management System.

12.6.3.6 Uninterruptible Power Supply (UPS)

Two static UPSs and batteries will be provided to give A&B UPS supplies (2N redundancy).

UPS will be high efficiency with multiple operating modes (VFI, VI, VFD) including energy saving modes.

Both will be rated to be capable of supporting all essential services in the TER, control room and tunnel.

The UPSs will comply with I.S. EN 62040 ‘Uninterruptible Power Systems (UPS)’.

12.6.3.7 LV Switchgear

Two main switchboards will be provided for the A and B supplies.

Automatic Power Factor Correction (PFC) equipment will be connected to the switchboards.

All Switchboards and Distribution Boards will comply with I.S. EN 61439 ‘Low Voltage Switchgear and Controlgear Assemblies’.

12.6.3.8 Power Management System (PMS)

A Power Management System will be provided to automatically control the switching between mains incomer, generator and UPSs.

The control system will be able to synchronise the generators to the electrical supply for testing and no-break return to mains.

12.6.3.9 Power Monitoring System

Power meters will be installed on all supplies from the main switchboards and in individual sections of distribution boards.

A power monitoring package will monitor, record, analyse and present power data from the meters in spreadsheet and graphical form.

This will form part of the Building Management System (BMS).

12.6.3.10 Cable Support & Containment

A complete cable support and containment system will be installed using galvanised steel cable ladder, tray, basket, trunking, conduit and support steelwork.

ICT cabling distribution in the TER will be installed overhead (basket for copper and plastic trunking for fibre).

12.6.3.11 Small Power Distribution

Socket outlets will be provided as required for the operation and maintenance of the facility.

Dual redundant UPS supported A & B power supplies will be provided to racks in the TER via plug-in tap-offs on overhead A&B busways fed from dedicated Power Distribution Units (PDUs) in the TER.

Dual redundant UPS supported A & B power supplies will be provided to consoles in the control room.

12.6.3.12 Electric car Charging

Electric car charging stations will not be provided.

Underground ducting will be installed from the LV Switchroom to the car park to allow for future installation of stations.

12.6.3.13 Interior Lighting

LED luminaires will be used throughout. Generally, this will include downlights in circulation areas and toilets, recessed linear fittings in rooms and office spaces and surface mounted linear fittings in plantrooms.

Lux levels will generally be in accordance with CIBSE Code for Lighting 2012.

12.6.3.14 External Lighting

External lighting will be provided by wall and column mounted LED fittings. All external luminaires will be vandal proof fittings.

Lux levels will generally be in accordance with CIBSE Code for Lighting 2012.

A plan of the proposed external lighting arrangements is provided in **Drawings GCOB-3000-D-215** for Lackagh Tunnel Services Building and **GCOB-3000-D-216** in **Volume 2** for the Racecourse Tunnel Services Building.

12.6.3.15 Lighting Controls

A Lighting Control System (LCS) will be provided with a graphical front end on an LCS server.

Automatic (presence/absence detectors and light level sensors) and manual (switches) lighting control will be provided throughout.

External lighting will be controlled by external photocells and an on-off-auto switch in the distribution board.

12.6.3.16 Emergency Lighting

Emergency lighting shall be provided by separate dedicated non-maintained LED luminaires supported by a 3 hour Central Battery System (CBS).

Maintained self-illuminated exit signs will be provided on escape routes with non-maintained emergency bulkheads over external doors.

The emergency lighting installation will comply fully with I.S. 3217 and the CBS with I.S. EN 50171 ‘Central Power Supply Systems’.

12.6.3.17 Fire Detection & Alarm System (FDAS)

An analogue, fully addressable, automatic Fire Detection & Alarm System will be provided in the building. It will be Category L1 to cover all areas.

A Very Early Warning Aspirating Smoke Detection (VESDA) system will be provided in the TER and its underfloor void.

The system will comply with I.S. 3218 ‘Fire Detection and Alarm Systems for Buildings - System Design, Installation, Servicing and Maintenance’. All components will comply with I.S. EN 54 ‘Fire Detection and Fire Alarm Systems’.

12.6.3.18 Fire Suppression

A Fixed Gaseous Fire Extinguishing System will be provided in the TER.

The extinguishing agent shall work by using a heat absorption/chemical reaction process. It will be stored as a fluid and change to gas when released into the room. The storage cylinders will be stored in an adjacent separate room.

The system will comply with I.S. EN 15004 “Fixed firefighting systems - Gas extinguishing systems” and ISO 14520 “Gaseous fire-extinguishing systems”.

12.6.3.19 Information & Communication Technology (ICT)

All ICT cabinets will be located in the TER.

All ICT outlets in the building will be wired to the racks in the TER using horizontal Cat 6A cabling.

A wireless network (WLAN) will be provided within the building.

12.6.3.20 Distributed Antenna System (DAS)

A full, multi-operator, repeater fed, active, fibre optic distribution system will be installed to allow mobile phone coverage in the tunnel.

A Point of Interface (POI) will be provided in a DAS room in the TSB to allow multiple GSM operators to connect their networks to the DAS which will combine and distribute the signals through antennas in the tunnel bores.

12.6.3.21 Intruder Detection & Alarm System (IDAS)

An Intruder Detection and Alarm System will be provided to prevent unauthorised access to the compound and building.

The system shall comply with I.S. EN 50131 'Alarm Systems – Intrusion Systems'.

12.6.3.22 CCTV

CCTV surveillance will be provided at the main gate, car park, building perimeter, entrances/exits, reception, lobbies and TER.

The CCTV system will be an IP PoE system generally comprising of internal and external cameras, colour display monitors, network recorder and associated equipment.

Images will be recorded on a local Network Video Recorder (NVR).

The system will comply with I.S. EN 50132 'Alarm Systems – CCTV Surveillance Systems for use in Security Applications'.

12.6.3.23 Access Control System (ACS)

Access control will be provided at access gates, entrances/exits, secure rooms and plantrooms to regulate access to secured areas of the facility.

Internally, proximity card readers will be used. External card readers will include a keypad for additional security (requires card and PIN for entry).

The system shall comply with I.S. EN 50133 'Alarm Systems – Access Control Systems for use in Security Applications'.

12.6.3.24 Earthing and Bonding

A complete earthing and bonding system will be provided in full compliance with all requirements of the relevant standards and regulations.

The Main Earthing Terminal (MET) for the installation will be an earth bar in the LV Switchroom and the earthing and bonding system will be connected to that point.

A separate functional/clean earth will be provided. This will be connected directly to the MET only. A functional earth bar will be provided in the TER to connect all clean earths in the room.

12.6.3.25 Lighting Protection System (LPS)

A Lightning Protection System (LPS) will be provided on the building. The Lightning Protection Level (LPL) class will be based on a specific risk assessment carried out for the facility.

The LPS will be fully coordinated with the surge protection system.

The system will generally comprise roof level air termination network, dedicated down copper tape conductors, earth electrodes, test points and bonding of all extraneous metalwork.

The system and equipment shall comply with I.S. EN 62305 ‘Protection Against Lightning’ and I.S. EN 50164 ‘Lightning Protection Components (LPC)’.

12.6.3.26 Surge Protection

Electrical and electronic systems within the building will be protected from any damage which may be caused by lightning electromagnetic impulse (LEMP) by designing, installing and testing a LEMP Protection Measures System (LPMS).

Service entry Surge Protection Devices (SPDs) and co-ordinated SPDs will form an integral part of the installation in keeping with the determined LPL protection level from the lightning protection system risk assessment.

All cables including incoming data links and comms lines entering the building will be surge protected with service entry SPDs.

The system and components shall comply with I.S. EN 62305-4 ‘Protection against lightning. Electrical and electronic systems within structures’ and I.S. EN 61643 ‘Low Voltage Surge Protection Devices’.

13 Construction Phasing, Traffic & Waste Management

13.1 General

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 adjoining lands. The duration of these works will vary. In the worst-case scenario these potential impacts will only last the estimated construction time identified in **Table 13.1** below for each section. A strategy for construction has been developed with the aim of minimising potential environmental impacts at each subsequent phase of the project.

13.2 Site Compound Locations

There are 13 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. The 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 for a temporary acquisition for the purposes of construction where the ownership will be 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. Refer to **Table 13.1** for the potential site temporary site compound locations and Refer to Figures 7.001 and Figure 7.002 of the EIA Report.

Table 13.1: 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

Site No.	Location	Service Range (Chainage)		Approx. Site Area (ha)	Access	Main Construction Activities
		From	To			
SC 05/01	Ballymoneen	Ch. 5+250	Ch. 6+300	1.0	Cappagh Road	Aille Cutting, Letteragh and Rahoon Road Overbridge
SC 07/01	Letteragh	Ch. 6+300	Ch. 9+350	3.3	N59 Moycullen Road	Major cut at Letteragh for GSJ and River Corrib Bridge (western section) Rock Crushing & Regrading Plant
SC 08/01	Dangan (Aughnacurra)	Ch. 8+550	Ch. 9+350	0.4	N59 Moycullen Road	River Corrib Bridge (western section). Used 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)

Site No.	Location	Service Range (Chainage)		Approx. Site Area (ha)	Access	Main Construction Activities
		From	To			
SC 15/01	Coolagh / Briarhill	Ch. 15+200	Ch. 16+100	0.5	R338 Monivea Road	Racecourse Tunnel (eastern section)
SC 16/01	Coolagh	Ch. 16+100	Ch. 17+500	1.3	R338 Monivea Road	Coolagh Junction

13.3 Construction Phasing

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

Completion of Phase 1 would provide the benefit of a new crossing of the River Corrib 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.

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. **Table 13.2** below summarises the proposed construction sections as per the potential phasing described above.

Table 13.2: 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

Section No.	Phase	Location	Chainage (m)		Length (m)	Time Constraint	Estimated Construction Time (months)
			From	To			
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
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

Section No.	Phase	Location	Chainage (m)		Length (m)	Time Constraint	Estimated Construction Time (months)
			From	To			
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

13.4 Construction Traffic

13.4.1 General

A preliminary investigation of the construction traffic was carried out to determine the estimated heavy good vehicle (HGV) movements required to transport the materials extracted and delivered to site. It should be noted that only registered vehicles will be permitted on public roads. **Table 13.3** below gives a summary of this assessment.

For the purposes of this assessment the expected HGV volumes were divided into seven zones:

- Zone 1 Ch. 0+000 – Ch. 3+900
- Zone 2 Ch. 3+900 – Ch. 7+750
- Zone 3 Ch. 7+750 – Ch. 9+300
- Zone 4 Ch. 9+300 – Ch. 11+140
- Zone 5 Ch. 11+140 – Ch. 14+140
- Zone 6 Ch. 14+150 – Ch. 16+200
- Zone 7 Ch. 16+200 – Ch. 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).

Table 13.3: Increase in HGV Percentage by Zone

Zone Reference	**Location Reference**	**Existing Daily HGV's**	**Additional daily HGV's over construction period per parameters sheet**	**Daily construction related AADT over construction period per parameters sheet**
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

13.4.2 Construction 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.

13.4.3 Road Closures and Temporary 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 main 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. A plan outline of these proposed temporary diversions is presented in Drawings **GCOB-100-D-400** to **408** in **Volume 2**.

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 Bóthrín, Bóthar Nua, An Seanbóthar, N84 Headford Road, N83 Tuam Road, Briarhill Business Park Road and R339 Monivea Road.

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 the shopping centre to the Gort na Bró Road. Details of these road closures are shown on Drawings **GCOB-100-D-400** to **408** in **Volume 2**.

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 with the exception of the permanent road closures.

13.5 Waste Management

13.5.1 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 generated, 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. Only where there is no alternative, will waste be disposed of to landfill. To achieve this, existing waste management programmes and networks will be used, such as the National Waste Prevention Programme, which is implemented by the Environmental Protection Agency.

All waste removed from the site will only be collected 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 obtained the 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.

13.5.2 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 under the following headings:

- The Demolition Phase
- The Excavation Phase
- The 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 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.

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.

13.5.2.1 Demolition Phase

An estimated 48,773 tonnes surplus demolition material (residential & commercial) will be generated as a result of the proposed road development.

13.5.2.2 Excavation Phase

An estimated 3,189,600m^3 of excavated material will be reused within the proposed road development.

An estimated 15,200 tonnes (7,600m^3) of waste will be generated as a result of the proposed development.

13.5.2.3 Construction Phase

In general, construction waste materials may include general construction debris, scrap timber and steel, machinery oils and greases and chemical cleaning solutions. The practice of excessive purchase of materials and equipment to allow for anticipated wastage will be avoided.

13.5.3 Construction and Demolition Waste Management Plan for the Construction Phase

The Contractor will prepare a detailed Construction and Demolition (C&D) Waste Management Plan for the proposed road development following appointment which will meet 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 responsible for implementing the *Outline Construction and Demolition Waste Management Plan.*

The key principles underlying the plan will be to minimise waste generation and to segregate waste at source.

The measures to achieve these aims include:

- Ordering of appropriate quantities of materials, with a just-in-time philosophy
- Immediate and careful storage of materials delivered to the site
- Storing materials which are vulnerable to damage by rain under cover and raised above the ground
- Careful handling of materials, using appropriate equipment, to avoid undue damage
- Designation of separate storage areas for different types of waste, in order to maximise the reuse and recycling potential of the waste

The Construction and Demolition Waste Management Plan will outline how residual waste will be handled as follows:

- The identification of disposal sites
- The identification of quantities to be excavated and disposed of and classification of this material
- The identification of measures to prevent nuisance, etc.
- The identification of the amounts intended to be stored temporarily on site and the location of such storage
- The contractor's approach to waste management
- The names, roles, responsibilities, and authority of the key personnel involved in the waste management

The C&D Waste Management Plan will include documented procedures for dealing with waste management including liaison with third parties, statutory undertakers and other companies.

The C&D Waste Management Plan will meet the requirements of the guidelines prepared by the National Construction and Demolition Waste Council (NCDWC), *Best Practice Guidelines on the Preparation of Waste Management Plans for Construction & Demolition Projects*, NCDWC 2006.

13.6 Safety

Transport sector proposals have a significant impact in terms of improving the safety record of transport infrastructure. In fact, transport policy has a focus on the reduction of collisions, and project design in road and public transport emphasises accident reduction. Higher capacity roads, and especially motorways, tend to be safer as a result of the segregation of traffic flows and a reduction in the number of road accesses. Where, as a result of a public transport investment, car user's switch to the public transport mode, there will tend to be a collision reduction benefit.

As noted, a key project objective of the proposed road development is the reduction of road traffic collisions by providing safer urban streets. Road traffic collisions, which include fatal accidents, are forecast for reduction due to the delivery of the proposed road development. The associated economic safety benefits were quantified as part of the economic assessment, for details refer to **Chapter 15, Economic Assessment** of this Report.

In addition, significant safety benefits may be accrued as a result of the implementation of the measures outlined within the Galway Transport Strategy.

The constructability, operation and maintainability of the proposed road development has been examined throughout the design process and has driven design development. During Phase 3 the design has been developed to a level which enabled the identification of the extent of land necessary to facilitate the safe construction, maintenance and operation of the proposed road development.

14 Road Safety Audit

14.1 Stage F (Part 2) Road Safety Audit

An independent auditing team from Arup Dublin were appointed to conduct Stage F (Part 2) Road Safety Audit on the preferred route corridor of the proposed N6 Galway City Ring Road. The audit was completed on the 24 August 2015 in the Arup Dublin office and included a site visit on the 12 August 2015. This Stage F audit was carried out in accordance with the relevant sections of GE-STY-01024. The team examined only those issues within the design relating to the road safety implications of the scheme, and has therefore, no examined or verified compliance of the design or any other criteria.

Refer to **Appendix A.14.1** for full details of the Stage F (Part 2) Road Safety Audit and Designer Response form.

14.2 Stage 1 Road Safety Audit

An independent auditing team from Arup Dublin were appointed to conduct a Stage 1 Road Safety Audit on the proposed road development. The audit report was completed on November 11, 2016 following a desktop review and site visit on November 7, 2016. This Stage 1 road safety audit was carried out in accordance with the relevant sections of GE-STY-01024 – Road Safety Audit. The audit team examined only those issues within the design relating to the road safety implications of the scheme, and has therefore, not examined or verified compliance of the design with the relevant standards or any other criteria.

Refer to **Appendix A.14.2** for full details of the Stage 1 Road Safety Audit and Designer Response form.

15 Economic Assessment

15.1 Introduction

15.1.1 Overview

An Economic Assessment has been carried out in accordance with Transport Infrastructure Ireland (TII) Project Appraisal Guidelines (PAG) October 2016. This will be referred to as TII PAG throughout this section of the Design Report. The cost benefit analysis program TUBA v1.9.5 has been used for the analysis.

Cost Benefit Analysis (CBA) forms one element of the appraisal process for road infrastructure projects. At the Design Phase (Phase 3), the benefits and costs of the proposed scheme are assessed using agreed land use growth scenarios. The TUBA program compares the "Do-Minimum" scenario (i.e. not to progress with the scheme) with the "Do-Something" scenario (i.e. the proposed road development) and determines whether benefits resulting from the scheme will outweigh the costs of construction and future maintenance.

At Phase 3 Design, the CBA should be undertaken at a scale that is appropriate for the phase of scheme appraisal. It was agreed with TII that the CBA would be carried out for the 30year appraisal period for the low, medium and high growth scenarios. It was also agreed to undertake a CBA for the proposed road development with measures from the Galway Transport Strategy in place using the medium growth scenario.

At this stage, detailed local parameter values for traffic composition have been used.

The results confirm that the proposed road development is an economically viable scheme.

15.1.2 Do Minimum Network

The future year 'Do-Minimum' network includes the 2012 base network plus all the schemes (highway and PT) that are already built, or are committed, 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. These schemes are detailed within the Traffic Modelling Report (TMR) which is included as **Appendix A.2.1** of this report.

15.1.3 Do Something

The future year 'Do-Something' networks include the Do-Minimum plus the N6 Galway City Ring Road (GCRR). In addition to the validated 2012 base year network, the future year networks developed are:

- 2024 Opening Year Do-Minimum
- 2024 Opening Year Do-Something
- 2039 Design Year Do-Minimum

- 2039 Design Year Do-Something
- 2054 Forecast Year Do-Minimum
- 2054 Forecast Year Do-Something

15.1.4 Do-Something with Galway Transport Strategy (GTS)

In 2016 the National Transport Authority (NTA), in association with Galway City Council and Galway County Council, prepared the Galway Transport Strategy (GTS). The GTS main report is appended to the Traffic Modelling Report contained in **Appendix A.2.1**. The GTS sets down a framework for how Galway's transport network can be redefined to address existing transport issues as well as catering for the future development of the city. In line with the aims and objectives of previous studies, the principal aim for the GTS is to seek to:

"Examine potential options to improve Galway's transport network and identify a package of measures within an agreed programme of infrastructural development which will enable the transport network of Galway City to serve travel demand in the most efficient, effective and sustainable manner".

The GTS outlined a host of proposed measures for active travel, public transport and general traffic in Galway, to be implemented over a 20year period. Some of the key proposals included in the Strategy are listed below:

- A public transport corridor through the City Centre where public transport only is 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 the bus route network and increase service frequencies
- Provision for park and ride

In addition to the Core Scenarios tested (listed above in **Section 15.1.3**) a further sensitivity test has also been carried out to assess the performance of the proposed road development in conjunction with all of the complementary schemes included in the Galway Transport Strategy. As the GTS is a 20-year strategy, this sensitivity test has only been carried out in the 2039 Design Year. The GTS sensitivity tests have been run using TII central growth forecasts.

15.1.5 Economic Assessment Input Assumptions

All general parameters such as value of time, value of time growth rates, discount rates, fuel cost changes, fuel consumption, vehicle operating costs fuel / non fuel, trip purpose distribution, tax rates, change in tax rates, vehicle occupancy rates, vehicle proportions and collision rates were taken from TII Publications PE-PAG-02030 - Project Appraisal Guidelines for National Roads Unit 6.11 - National Parameters Values Sheets (October 2016).

TII provided a TUBA Economics parameters file in October 2016. This file was slightly altered to make it consistent with NTA Regional Model System outputs and to adapt it to the area of the project covered by the Western Regional Model.

The parameters that have been changed in the TII standard parameters file (October 2016) are:

- TUBA Version
- Traded carbon value
- Modes
- Vehicles types / sub-modes
- Time Periods
- Default Purpose Split
- Default Person Factors

The Cost Benefit Analysis (CBA) Report outlines the origin of all economic parameters utilised as part of the economic assessment. The CBA report is included as **Appendix A.15.1** of this report.

15.2 Scheme Costs – Capital Costs

15.2.1 Scheme Costs – Capital Costs

As stipulated in the Project Appraisal Guidelines, costs are represented in 2011 prices and values exclusive of VAT are used in CBA appraisal. The Total Scheme Budget (TSB) and Target Costs (TC) are set out below, in 2016 cost estimates. These costs have been developed and agreed with TII.

The TSB was prepared based on the base costs of construction, supervision, archaeology, advance works, residuals, land & property and planning & design but supplemented by a TII Programme Risk and Total Inflation allowance. The TSB is outlined in **Table 15.1** below, inclusive of VAT. Note that for appraisal purposes and in accordance with PAG Unit 6.7, costs have been input into TUBA exclusive of VAT.

Table 15.1: Capital Costs – Total Scheme Budget Estimate (2016 prices)

Cost	€ M (INCL. VAT)
Total Scheme Budget	593.33
Target Cost	558.29
Inflation allocated to Target Cost	39.58

As required by the current guidance from the Department of Transport Tourism and Sport (DTTAS) Common Appraisal Framework (CAF) (2016), a shadow price factor of 1.3 has been applied for public funds. In line with the CAF, the economic appraisals have been estimated on the basis of a shadow price of labour of 0.8.

The process of accounting for the changes in the price of construction relative to movements in the general price index is undertaken by application of the Relative

Price Factor (RPF). As specified by TII PAG 6.2, an RPF value of unity was applied.

Accounting for shadow pricing, excluding VAT, the cost input in TUBA is summarised in **Table 15.2**.

Table 15.2: Total Scheme Budget – TUBA input 2011 factor price

TUBA Cost Categories	Cost €1,000
Construction	378,735
Supervision	11,521
Land	202,807
Planning	19,312
Subtotal	612,376

15.2.2 Do Minimum Costs

No additional cost associated with the Do Minimum scenario only was included in the appraisal.

15.2.3 Scheme Costs – Maintenance and Operating Costs

Annual maintenance costs have been included in the appraisal. The default maintenance costs by road type in TII Publications PE-PAG-02030 PAG Unit 6.11 have been used based on the lengths of standard cross-section.

Annual O&M cost for tunnels and bridges has been included. The same assumptions as for the main construction contract have been applied in terms of percentage of public funding, labour content and shadow prices.

A summary of the annual operating and maintenance cost estimate in 2011 factors prices is provided in **Table 15.3** below.

Table 15.3: Operating and Maintenance cost estimate

Operating and Maintenance cost estimate	Annual cost 2011 prices, factor costs (€1,000)
Tunnel O&M per year	2,401
Bridges and viaduct O&M per year	62
Single carriage way	104
Dual carriageway	443
Total	3,010

Over the 30 years of the appraisal, the total O&M costs are estimated at €90,307,000 (2011 factor costs).

15.2.4 Residual Value

For major transport schemes, the residual value is a measure of the net present value of the infrastructure over a specified period beyond the 30-year appraisal period. In this case a residual value period of 30 years is applied based on the guidance outlined in Table 6.1.2 of TII Publications PE-PAG-02020 Project Appraisal Guidelines for National Roads Unit 6.1: Guidance on Conducting CBA. The residual value is included in the final table of results.

15.2.5 Safety CBA Benefits

An assessment of potential safety benefits has been undertaken using the Irish version of COBALT software.

The COBALT assessment is based on a comparison of collisions by severity and associated costs across an identified network in a ‘Without-Scheme’ and ‘With-Scheme’ scenario, using details of link characteristics, collision rates, casualty costs and projected traffic volumes.

As the Central Statistics Office (CSO) do not provide growth forecasts up to 2054 or beyond, the safety analysis for the Low Growth scenario has been based on 2024 and 2039 model outputs only. For all other scenarios this process was undertaken using the Opening (2024), Design (2039) and Forecast (2054) Year models. Collision costs for the entire 30-year appraisal period (2024 - 2054) were calculated based on interpolated costs between the Opening Year and 2054.

The COBALT version and input parameters file from TII Publications PE-PAG-02024 – PAG Unit 6.5 – TUBA and COBALT Sample Input Files (October 2016) has been used to undertake the safety appraisal.

The COBALT software parameters file contains standard collision rates for various road types. Where relevant road traffic accident information is available from the Road Safety Authority (RSA), the standard collision rates have been replaced with local collision data in order to provide a more accurate estimate of safety benefits of the proposed road development. The table below outlines the collision rates obtained from the RSA for national roads in the Study Area and used in the COBALT analysis.

Table 15.4: Local Collision Rates

Road	**Collision Rate (per 106 Veh.km)**
N6	0.053
N83	0.090
N18	0.058
N59	0.100
N84	0.128

The results of the safety assessment are presented in **Table 15.5** to **Table 15.8**. The results show the discounted safety benefits in 2011 prices, exclusive of residual value. In all of the growth scenarios, the results indicate a positive impact on safety.

Table 15.5: Discounted Safety Benefits (2011 Values) – Low Growth

Scenario	Collision Costs (€'000)	Safety Benefits (€'000)
Do Minimum	2,017,969	-
Do Something	2,100,753	16,212

Table 15.6: Discounted Safety Benefits (2011 Values) – Central Growth

Scenario	Collision Costs (€'000)	Safety Benefits (€'000)
Do Minimum	2,128,783	-
Do Something	2,097,657	14,744

Table 15.7: Discounted Safety Benefits (2011 Values) – High Growth

Scenario	Collision Costs (€'000)	Safety Benefits (€'000)
Do Minimum	2,159,801	-
Do Something	2,143,234	16,566

Table 15.8: Discounted Safety Benefits (2011 Values) – GTS (Central growth)

Scenario	Collision Costs (€'000)	Safety Benefits (€'000)
Do Minimum	2,131,151	-
Do Something	2,100,753	13,999

15.3 Growth Scenarios and CBA Results

15.3.1 Low Growth Scenario

The Low Growth scenario is based on CSO M2F2 growth forecasts with the distribution of growth provided by the NTA planning department. As the CSO do not provide growth forecasts up to 2054 or beyond, the cost benefit analysis for the Low Growth scenario has been based on 2024 and 2039 model outputs only.

Annual maintenance costs for the scheme have been included in the appraisal as per the methodology described in **Section 15.2.3**.

For the low growth scenario, the Present Value of Benefits of €1,494m is approximately comprised of the following over the total appraisal period:

- + €995m in business and consumer user benefits
- + €16m safety benefits
- + €3m indirect tax revenues (cost)
- + €480m residual value benefits

15.3.2 Central Growth Scenario

For the central growth scenario, the Present Value of Benefits of €1,781m is approximately comprised of the following over the total appraisal period:

- + €1,160m in business and consumer user benefits
- + €14.7m safety benefits
- + €3m indirect tax revenues (cost)
- + €587m residual value benefits

15.3.3 High Growth Scenario

For the high growth scenario, the Present Value of Benefits of €1,888m is approximately comprised of the following over the total appraisal period:

- + €1,212m in business and consumer user benefits
- + €16m safety benefits
- + €3m indirect tax revenues (cost)
- + €655m residual value benefits

15.3.4 Galway Transport Strategy Sensitivity Test

For the GTS scenario, the Present Value of Benefits of €1,518m is approximately comprised of the following over the total appraisal period:

- + €1,007m in business and consumer user benefits
- + €14m safety benefits
- + €3m indirect tax revenues (cost)
- + €477m residual value benefits

It should be noted that the costs and benefits outlined above for the GTS Scenario do not include any benefits from the proposed Public Transport elements of the Galway Transport Strategy or the costs of implementing any of the GTS proposals. For the purposes of this analysis only costs and benefits associated with the N6 GCRR have been considered.

15.3.5 Conclusions

The Economic Assessment has been undertaken using the TUBA software programme in accordance with TII Project Appraisal Guidelines 2016. The assessment has demonstrated Benefit to Cost Ratio values over a 30-year appraisal period (inclusive of residual value) based on the Target Costs and the Total Scheme Budget costs as presented in **Table 15.9** and **Table 15.10**.

Table 15.9: Target Cost - Cost Benefit Analysis Summary Table (€'000)

Option	PVB (Present Value of Benefits)	PVC (Present Value of Costs)	NPV (Net Present Value)	BCR (Benefit to Cost Ratio)
Low Growth Target Costs	1,494,217	425,686	1,068,531	3.51
Medium Growth Target Costs	1,781,208	427,458	1,353,750	4.13
High Growth Target Costs	1,887,812	425,879	1,461,933	4.43
GTS Scenario	1,518,620	429,482	1,089,138	3.50

Table 15.10: Total Scheme Budget - Cost Benefit Analysis Summary Table (€'000)

Option	PVB (Present Value of Benefits)	PVC (Present Value of Costs)	NPV (Net Present Value)	BCR (Benefit to Cost Ratio)
Low Growth Total Scheme Budget	1,494,217	452,562	1,041,655	3.30
Medium Growth Total Scheme Budget	1,781,208	454,334	1,326,874	3.88
High Growth Total Scheme Budget	1,887,812	452,754	1,435,058	4.17
GTS Scenario	1,518,620	456,358	1,062,262	3.29

Since Phase 2 Route Selection, a number of inputs and parameters have changed which impact on the Cost Benefits Appraisal:

- The latest release of PAG by TII has been used (2016 vs 2011 previously) with the subsequent changes in discount rates, shadow pricing, values of time
- Refined multi-modal models have been used with a much greater level of detail: tour-based model, 5 modes, mode-destination choice over 33 purposes, 3 parking models, 4 assigned time periods, 749 zones
- The benefits of four calibrated time periods are being assigned instead of two previously
- Annualisation factors have been updated to account for the additional modelled periods
- The current model covers a larger area (6 counties)
- Benefits for Public Transport users have been included
- Local parameters for vehicle occupancy and purpose have been estimated
- The safety benefits have been estimated using COBALT software instead of an excel based analysis
- Different trip end growth scenarios have been used
- A more refined estimation of total scheme budget (including O&M costs) has been applied with a detailed breakdown of investment per year

Based on the TII methodology for road projects, the results indicate that based on the scheme costs developed to date and the associated forecast performance of the transport network, the proposed scheme options represent value for money with forecast net present values in the region of €1.04bn - €1.46bn. The TUBA output files are included in **Appendix A.15.1** of this Report.

15.4 Implementation

Financial Appraisal and Exchequer Analysis were undertaken in order to examine the impact of the implementation of the project on the finances of the Transport Infrastructure Ireland and the Exchequer respectively by considering the inflows and outflows for TII, as the project sponsoring agency, and doing an Exchequer cash flow analysis over a 30-year operating period starting in 2024.

The financing structure for the project was based on capital funding from Transport Infrastructure Ireland of 100% of the nominal capital costs. The Total Scheme Budget which includes the same capital costs as the Target Cost but is supplemented by a TII Programme Risk and Total Inflation allowance of the project is estimated at €488.58m in 2011 prices. The operation of the project, in 2011 prices, is estimated that it would cost Transport Infrastructure Ireland €3.01 million per annum equating to €90.31m over the 30-year appraisal period.

On major transport schemes, the residual value is a measure of the net present value of the infrastructure over a specified period beyond the 30-year appraisal period. In this case a residual value period of 30years is applied based on the guidance outlined in Table 6.1.2 of TII PAG Unit 6.1: Guidance on Conducting CBA. The residual value offsets the Total Scheme Budget cost and the operation cost and for the purposes of the financial appraisal, the residual value is taken as the original capital cost of the infrastructure on the basis that the maintenance in the first 30 years is sufficient to ensure that the infrastructure will continue to provide an identical level of service.

Therefore, the project, in 2011 prices, is estimated that it would result in a net cost to the Exchequer of €103.9m over the 30-year appraisal period, increasing to €134.81 when programme risk is included.

The implementation of the project would be subject to change and availability of funding. The following key principles relate to the implementation:

- The full project will be promoted as one project through the Statutory Process
- The project may be procured as smaller construction contracts constructed concurrently
- The location of the split or the number of contracts has not been determined as of yet
- Construction could be phased
- Advance works contracts will be used as appropriate

Given the scale of this project and given the fact that it can be sub-divided in to smaller projects, it is likely that a Design & Build contract is utilised to better facilitate the affordability of the construction. A Public Private Partnership contract is also a possibility. It is intended that the proposed road development would not be tolled. Advance works contracts will be used as appropriate. To minimise tendering risk, it would also be recommended that a process of pre-qualification of suitable contractors be undertaken. From this process a shortlist of suitable tenderers would be invited to tender for the project.

16 Environmental Mitigation Design

16.1 National University of Ireland, Galway

16.1.1 Introduction

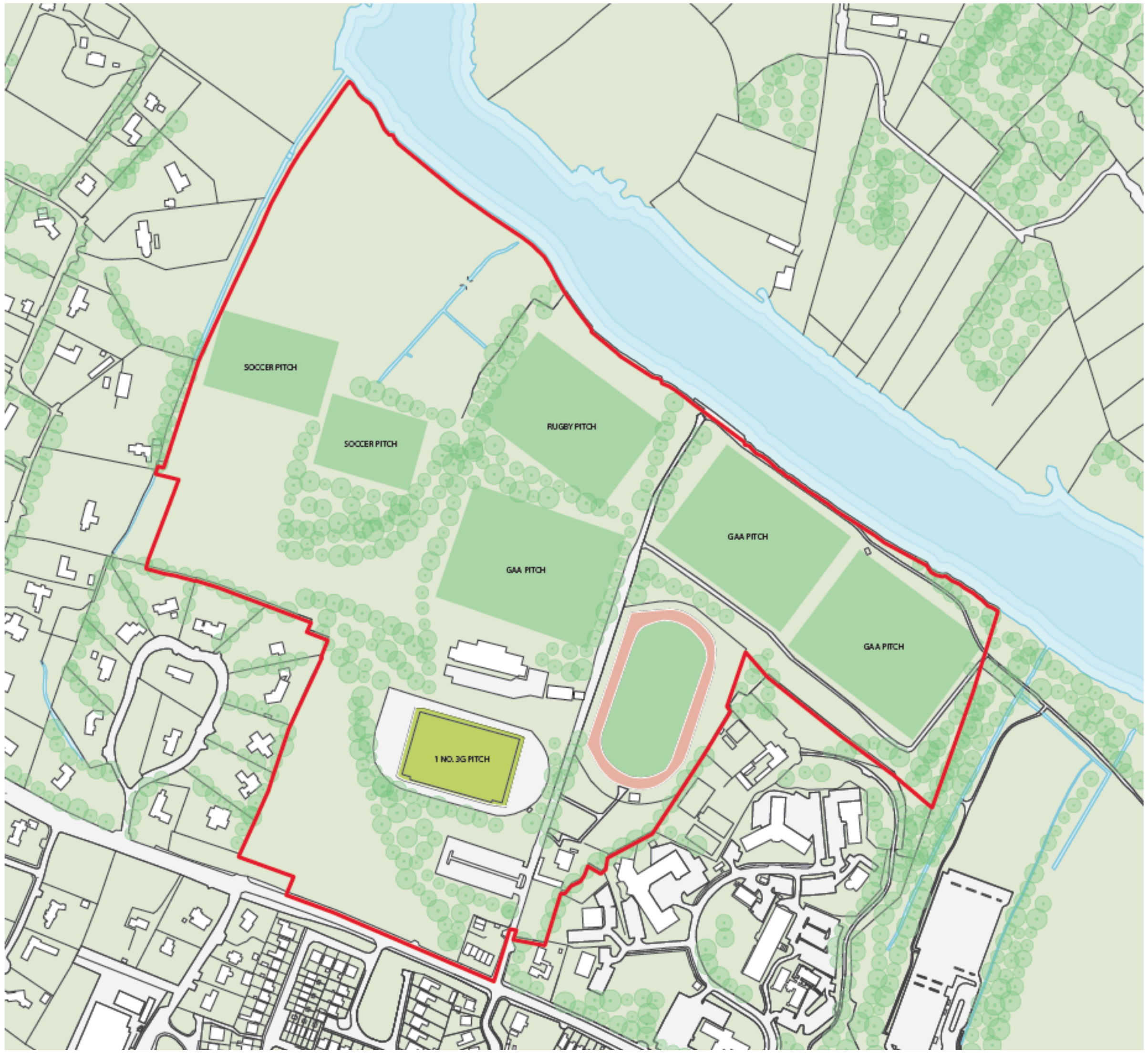
The proposed road development passes through lands owned by the National University of Ireland, Galway (NUIG) in the Dangan area of Galway City. The lands traversed form part of the university's sporting campus. **Figure 16.1** shows the existing sporting campus layout.

The proposed road development impacts the NUIG Sporting Campus. Potential impacts have been identified, examined and reported by Building Design Partnership Ltd (BDP). BDP is a major international practice of architects, designers, engineers and urbanists. BDP are recognised international university campus planners and have extensive campus planning experience in Ireland including the University of Limerick 2020 Vision.

The assessment highlighted the impact of the proposed road development on the sporting campus in the absence of mitigation. The physical impacts are as follows as follows:

- Removal of existing GAA pitch.
- Removal of existing training pitch (rugby pitch). This pitch has full planning permission for upgrade to a 3G all-weather with floodlighting.
- Impact to existing sports pavilion requiring modification works.
- The suitability of the existing pavilion as a component of the sporting campus would be undermined as facilities in its immediate vicinity would be removed.
- Increase in noise levels adjacent to the proposed road development.
- The segregation of the north-western sports campus from the south- eastern sporting campus.
- Impact to the sporting campus operations during construction and thereafter. This impact relates to the timetabling of sporting events by the university. That is, the impacts of construction and operation may hinder the ability of the university to accommodate sporting events due to reduced facilities.

Figure 16.1: Existing NUIG Sporting Campus



Sports Facilities	1,900m²
Athletics	1
GAA Pitches	3
Rugby Pitches	1
Soccer	2
Multipurpose 3G Arena / Training	1
5-a-Side 3G	0
Parking	181
Archery Range	0
Watersports	0

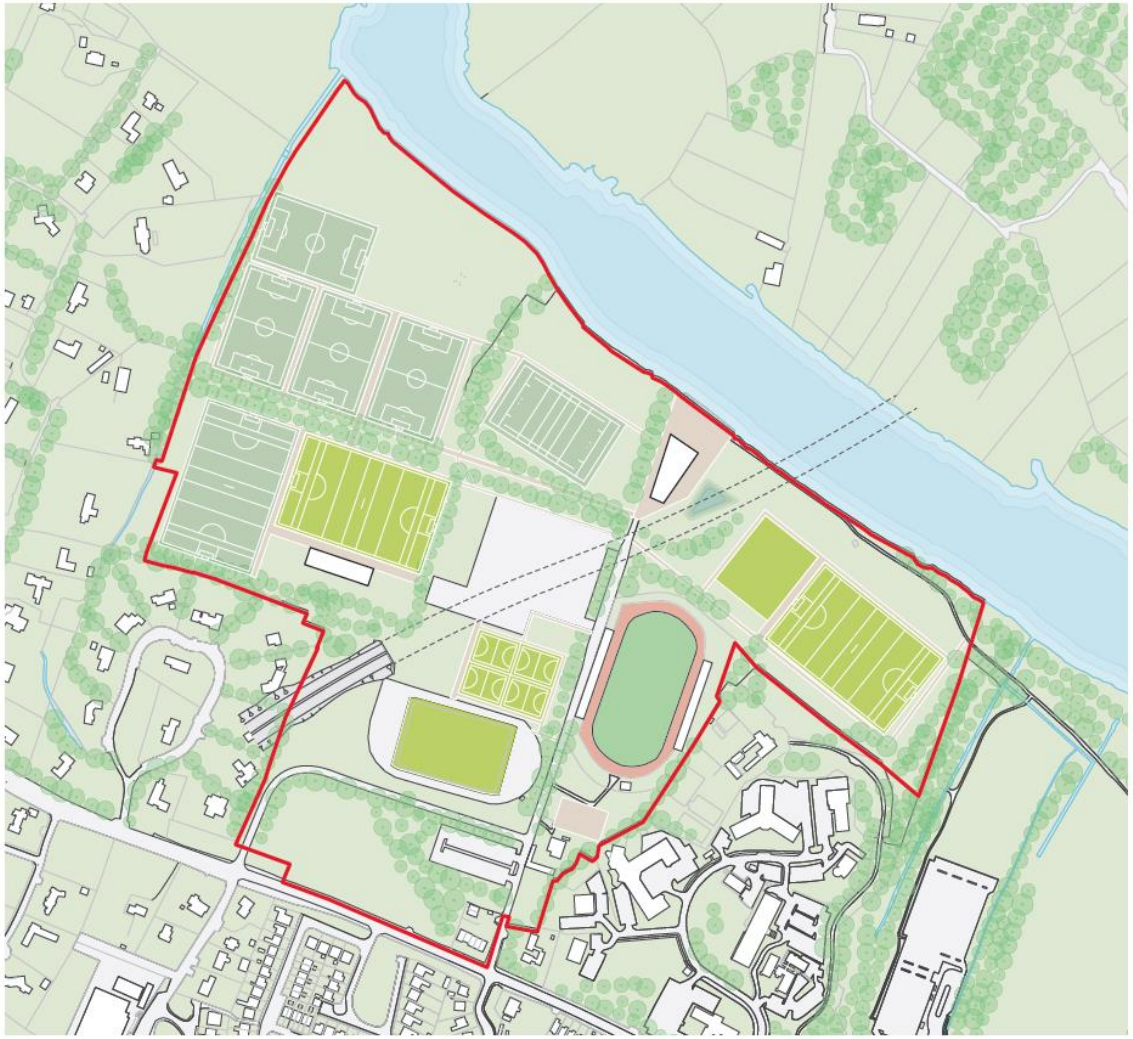
16.1.2 Stakeholder Consultation

The buildings and estates team at NUIG has engaged regularly with the project team during the design of the proposed road development. Engagement included submissions to the project team and consultation meetings. At these consultation meetings, the university highlighted the potential impacts which the proposed road development would inflict upon the university sporting campus.

The master planners engaged were tasked to identify, examine and report on the potential impacts. The conclusions of this report highlighted the need to assess whether the impacts posed by the development could be mitigated. This led to the preparation of a best fit layout for the sporting campus. The exercise was carried out to determine what facilities could be provided within the NUIG lands not directly impacted by the proposed road development. The results of this analysis were presented to the university.

The best fit analysis illustrated that significant facilities could be provided within the remaining NUIG lands not directly impacted by the proposed road development. However, this exercise did not conclude that the level of facilities, which could be provided within the best fit layout, would be insufficient, sufficient, or an overprovision with respect to the needs of the university's sporting offering, curriculum, objectives and priorities into the future. **Figure 16.2** shows the best fit layout derived following consultation meetings with the university.

Figure 16.2: Best fit layout sporting campus



Sports Facilities	4,600m²
Athletics	1
GAA Pitches	2
Rugby Pitches	1
Soccer	4
Multipurpose 3G Arena / Training	3
5-a-Side 3G	4
Parking	601
Archery Range	1
Watersports	1

16.1.3 Proposed Mitigation

The following mitigation is proposed to mitigate potential impacts which the proposed road development would have upon the university sporting campus. The mitigation is proposed by the masterplanner retained by the design team in the absence of an agreement or proposal for revised masterplan by the university.

3G GAA Pitch and 3G Practice Pitch:

It is proposed to provide one floodlit 3G training pitch and one floodlit 3G GAA pitch, both incorporating ball stop netting and all ancillary sports pitch furniture, to replace those facilities directly impacted, namely mitigation for the two GAA pitches impacted adjacent to the river, and the multi-purpose pitch in front of the pavilion which is also impacted by the proposed road development.

The design of the proposed 3G GAA pitch and 3G training pitch is detailed in **Section 16.1.5**. The plan layout of the proposed pitch facilities is indicated on Drawing **GCOB-000-D-007** in **Volume 2**.

Sports Pavilion:

The proposed road development intercepts the existing sports pavilion building resulting in direct impact to its western end. Modification works are necessitated to this structure because of the proposed road development, including structural and building services amendment and modification works to enable its continued use and functionality. Details are provided in **Section 16.1.4**.

Viaduct:

The proposed road development crosses the sporting campus on a viaduct structure. A viaduct structure has been provided as a mitigation measure to minimise the impact of the proposed road development on the sporting campus from an operational perspective. The inclusion of a viaduct reduces the segregation of the north-western sports campus from the south-eastern sports campus by maintaining permeability beneath the proposed road development.

The design of the viaduct is detailed within **Chapter 7, Structures** and **Appendix A.7.6** of this Report.

Noise Barrier:

A 2m high transparent noise barrier, that is integral with the proposed NUIG viaduct structure and the proposed River Corrib Bridge, has been provided as an environmental mitigation measure. This barrier mitigates against the potential noise impacts caused by the proposed road development.

Noise barriers are detailed within **Chapter 7, Structures** and **Appendix A.7.8** of this Report and are indicated on Drawings **GCOB-300-D-000** to **015** in **Volume 2**.

16.1.4 Sports Pavilion Building

The proposed modification works to the Sports Pavilion Building include the demolition and relocation of the existing plant room to the west, and the permanent demolition of and existing changing room and weights room. Two new entrance doors are required as part of the works. The proposed works are outlined on Drawings **GCOB-3000-D-221** to **227** in **Volume 2**.

Internally, modifications to the existing mechanical and electrical systems are required to reconnect the existing plant to the new plant room. This will ensure permanent functionality of the M&E services to the overall building.

16.1.5 3G Synthetic Pitches

The proposed 3G Synthetic surface has been designed in accordance with the 2009 GAA Code of Compliance, IRB and FIFA standards. The required build up for the synthetic pitches is shown on Drawing **GCOB-3000-D-103** in **Volume 2**.

16.1.6 Construction Access

An examination of how the River Corrib Bridge structure is to be constructed has been carried out and is detailed in the River Corrib Bridge Constructability Report contained in **Appendix A.7.6** of the EIA Report. Details of the access points and routes, that are to be maintained by the contractor for the university during construction, are provided on Drawing **GCOB-3000-D-104** in **Volume 2**.

16.1.6.1 Drainage Design

The runoff from the proposed 3G all-weather GAA pitch and training pitch will be collected in a series of 100mm lateral fin drains and distributed via gravity to a system of perimeter filter drains. The downstream discharge will be to an existing surface water drain which ultimately outfalls to the River Corrib. The filter drains will encourage infiltration along their length and offer recharge to the ground below the proposed pitches.

This system aims to replicate the existing greenfield scenario on the existing pitches, where low intensity storms would infiltrate to ground, while larger intensity storms would run overland and discharge to the downstream drains and river. Refer to Drawing **GCOB-3000-D-103** in **Volume 2** for the proposed drainage layout of the pitches.

16.1.6.2 Lighting Design

The design of the lighting for the pitch facilities was based on the standards set within the '*SLL Lighting Guide 4 – Sports Lighting*'. The main GAA pitch and the training pitch are Class II. This requires an average horizontal illuminance of 200 lux and a uniformity of 0.6. Refer to Drawing **GCOB-3000-D-102,** in **Volume 2** for the proposed lighting layout for the pitches.

16.1.6.2.1Design Approach

To reduce the potential lighting impact on the River Corrib, where bat roosts and bat flight paths have been identified, the lighting class of the main GAA pitch and the training pitch has been classified as Class II.

LED luminaires were used for both pitches with glare prevention louvres to minimise the light spill to surrounding areas.

Additionally, there is a 38kV high voltage power line crossing the training pitch. The location of lighting poles and offsets to the existing cables have been agreed with the ESB 38kV networks.

To further reduce obtrusive light, a custom hood has been modelled behind and over the projectors on the riverside to obstruct lighting for surrounding areas.

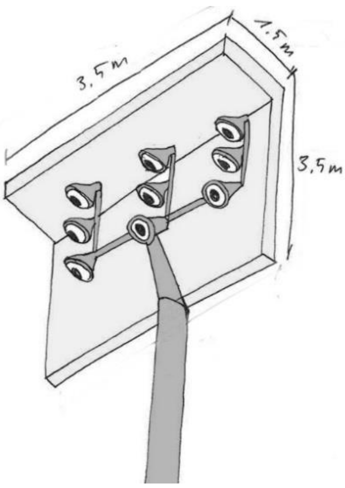
The design consisted of:

- 6 no. 18m columns with 8 no. LED luminaries mounted on each column around the main GAA pitch.
- 4 no. 18m columns around the training pitch, with 4 no. LED luminaires mounted on two columns and 5 no. LED luminaires on the other two. 1 no. column was set back from the training pitch towards the adjacent proposed road development to comply with the ESB 38kV power line requirements.

Figure 16.3: Philips OptiVision LED gen2 with asymmetrical 90°x50° wide beam and ArenaVision louvre used within the simulations presented.

Figure 16.4 shows a sketch of the proposed custom-made panel that functions as hood to reduce light spill from the projectors on the riverside to the surrounding areas.

Figure 16.4: Sketch of custom shielding device



16.1.6.2.2Results

Figure 16.5 below display the output of the calculations and simulations completed for the main pitch and **Figure 16.6** displays the output for the training pitch.

Figure 16.7 shows the calculated illuminance levels on the River Corrib.

The figures below must be read in conjunction with Drawing **GCOB-3000-102**, in **Volume 2** which displays the isolines output from the calculation onto a background of the site location.

From the analysis presented, the following observations can be made:

- Because of measures taken to reduce the light spill, 0 lux is observed on the majority of the River Corrib
- Because of the measures taken to reduce the light spill, 1 lux is observed on the river adjacent to the proposed sports grounds

Figure 16.5: Calculation output with pole locations for the main GAA pitch

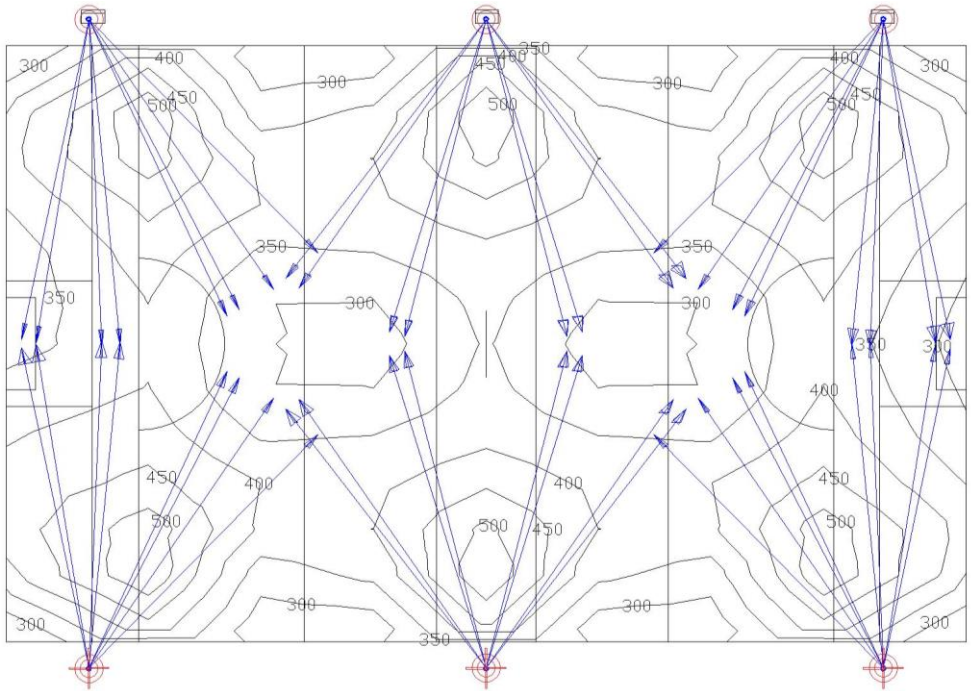


Figure 16.6: Calculation output with pole locations for the training pitch

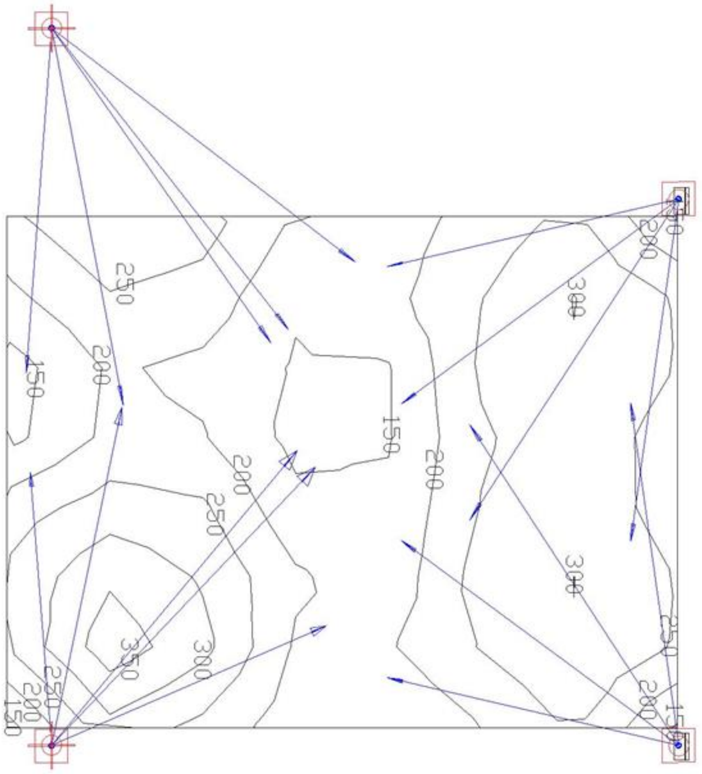
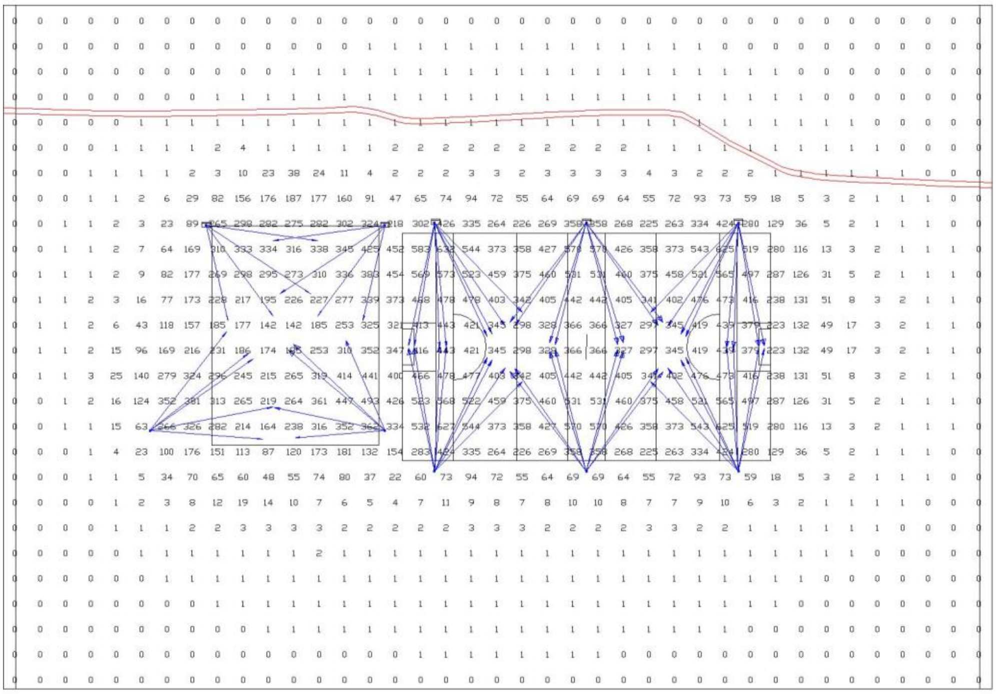


Figure 16.7: Illuminance levels on River Corrib (shown in red)

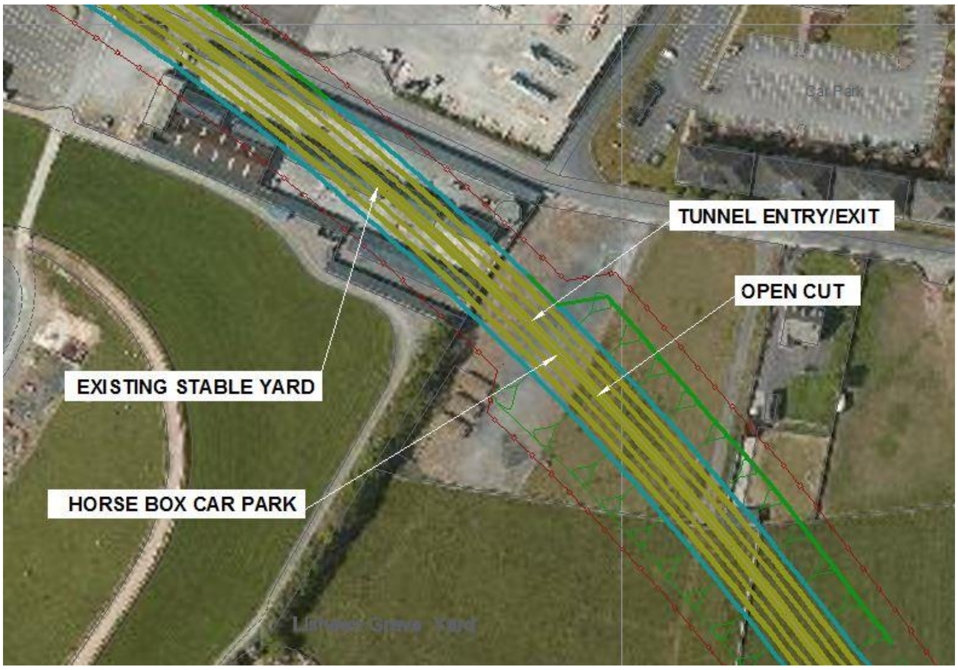


16.2 Galway Racecourse

16.2.1 Introduction

The proposed road development passes through lands owned by Galway Racecourse. The lands traversed form part of the Galway Racecourse. **Figure 16.8** below shows the proposed road development in relation to Galway Racecourse.

Figure 16.8: Galway Racecourse Stable Yard



The proposed road development impacts on Galway Racecourse and its facilities. The stable yard, horsebox car park, horse loading / unloading area, racecourse services, and the racecourse track watering supply wells in this area are impacted. These impacts arise as the proposed road development passes along the line of and beneath the existing stables and stable yard.

Galway Racecourse indicated that the use of the stables, in their current location, is of fundamental importance to the continued and optimal functioning of the racecourse. The Galway Racecourse Committee were consulted to obtain a detailed understanding of why the current location of the stables, with respect to the entire operation of the racecourse, is optimal and whether alternatives were possible.

The following is a list of both permanent and temporary impacts to the Galway Racecourse facilities at consequent the proposed road development:

Permanent Impacts:

- 165 stables will be demolished
- Horsebox parking area will be removed
- Maintenance and machinery shed will be demolished
- Turf Club vet boxes and security offices will be demolished
- Grooms canteen and toilets will be demolished

- 2 no. bored wells feeding 70,000 Gallon water tank at eastern end of stable yard will be demolished
- The 70,000gallon water tank for main track watering supply at eastern end of stable yard will be demolished
- Horse wash will be demolished
- Northern greenfield area, that is used for parking during festival time, will be impacted as well as third party lands which are also leased by the Galway Racecourse during festival time for parking

Temporary Impacts:

- Industrial Development Authority (IDA) wet services will require diversionary works; connection to internal wet service networks will require diversionary works
- Existing foul sewer connections to the IDA sewers relocated
- ESB connections to the stable yard and hospitality areas will require diversionary works
- A new connection will be required between a proposed replacement track watering well and storage tank to the track ring main
- The information and communication networks will require diversionary works
- Stewards car park will be impacted
- Boundary wall will be impacted
- Internal taxi road will be impacted

16.2.2 Stakeholder Consultation

As noted, Galway Racecourse were engaged to garner an informed view on the functioning of the stables in relation to the entire racecourse operation. This engagement served to comprehend why the current location of the stables is central, critical, and optimal with respect to the operation of the racecourse.

The consultation highlighted the interdependence of the stables location with the parade ring and the interdependence of the stable yard location and the track. These layout interdependencies dictate and limit the possibilities in terms of alternate sites for the stables or re-establishment of the stables elsewhere. As a corollary siting of such facilities must consider interaction, from a safety perspective, with pedestrians, patrons accessing the racing festival, and patrons accessing associated parking facilities. Isolation of the separate desire lines between race patrons, race traffic, and horses is essential from a safety perspective. Thus, this reinforces the limitations of identifying alternative sites for the stables.

Galway Racecourse reinforced that functionality of the stables during racing festivals is critical to the whole operation of the event. Monetary compensation is not adequate mitigation to address the relocation of stables as Galway Racecourse does not have the authority or a mechanism to acquire the critical replacement lands to deliver the stable yard and its associated infrastructure. Equally, planning permission for the replacement stables should be considered as part of the overall planning permission for the proposed road development as the replacement facilities must be in place in tandem with the removal of existing facilities due to the tunnel construction. The racecourse cannot operate without stables that are correctly positioned as they are intrinsically linked to all other operations and functions of the racecourse.

16.2.3 Programme of Works

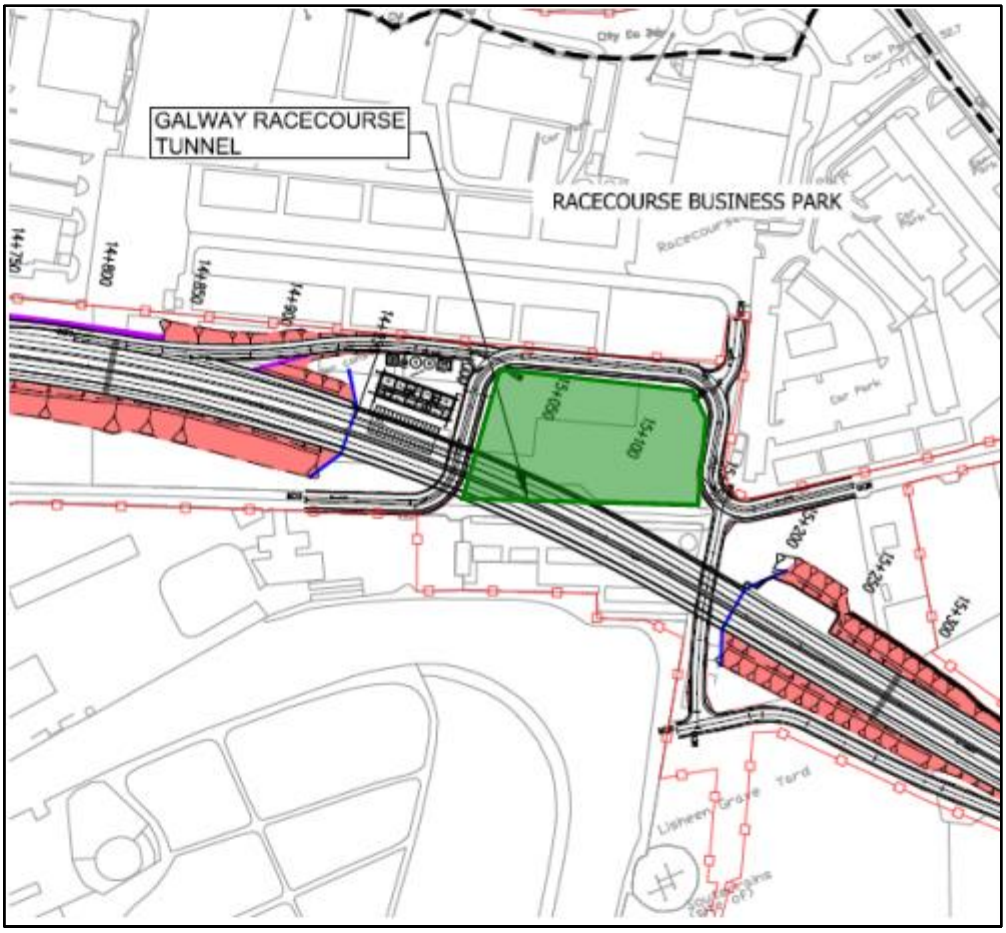
A construction programme of works has been compiled in conjunction with Galway Racecourse to minimise the disruption to the commercial operations of the business throughout the year, not only for the racing festivals. An advance works schedule is included in this programme which includes two well relocations and associated infrastructure, water, telecoms, E-net, 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 a nine-month construction window per year. Blasting of material will be required to remove shallow rock head which has been identified from ground investigation works. A permanent diversion of the main IDA surface water and foul sewer is required at the eastern portal of the proposed tunnel and diversions of the associated racecourse foul sewer and track surface water drain are also required along the route of this diversion. Further details are contained in the Galway Racecourse Tunnel Constructability Report contained in Appendix A.7.4 of the EIA Report. Refer to Drawings **GCOB-3000-D-300** to **313** in **Volume 2** for further details on construction stages.

16.2.4 Proposed Mitigation

As stated above, the interdependence of the stables with the parade ring, the stable yard and the track is fundamental to the optimal operation of the racecourse. Therefore, this limits the possibilities in terms of alternate sites for the stables or re-establishment of the stables. In order to achieve isolation of separate desire lines of race patrons, race traffic and horses the realignment of the Racecourse Avenue must consider this.

It has been strongly argued by the Racecourse Committee that relocating the stables over the line of tunnel in the existing yard is not a feasible solution due to the potential for noise and vibration impacts to horses. Therefore, an alternative location must be sought to maintain the function of the Racecourse. Additionally relocating the stableyard to the infield would require tunnelling underneath the track for access which the Racecourse are strongly opposed to due to potential affects to the going of the track. **Figure 16.9** below shows the proposed relocation for the stable yard north of the proposed alignment. This plot is included in its entirety in the Motorway Scheme due to the level of impact to the site both temporarily and permanently to facilitate the construction of the proposed road development. It is proposed to retain the remainder of this site as environmental mitigation for Galway Racecourse. This site is hereafter referred to as Brooks site.

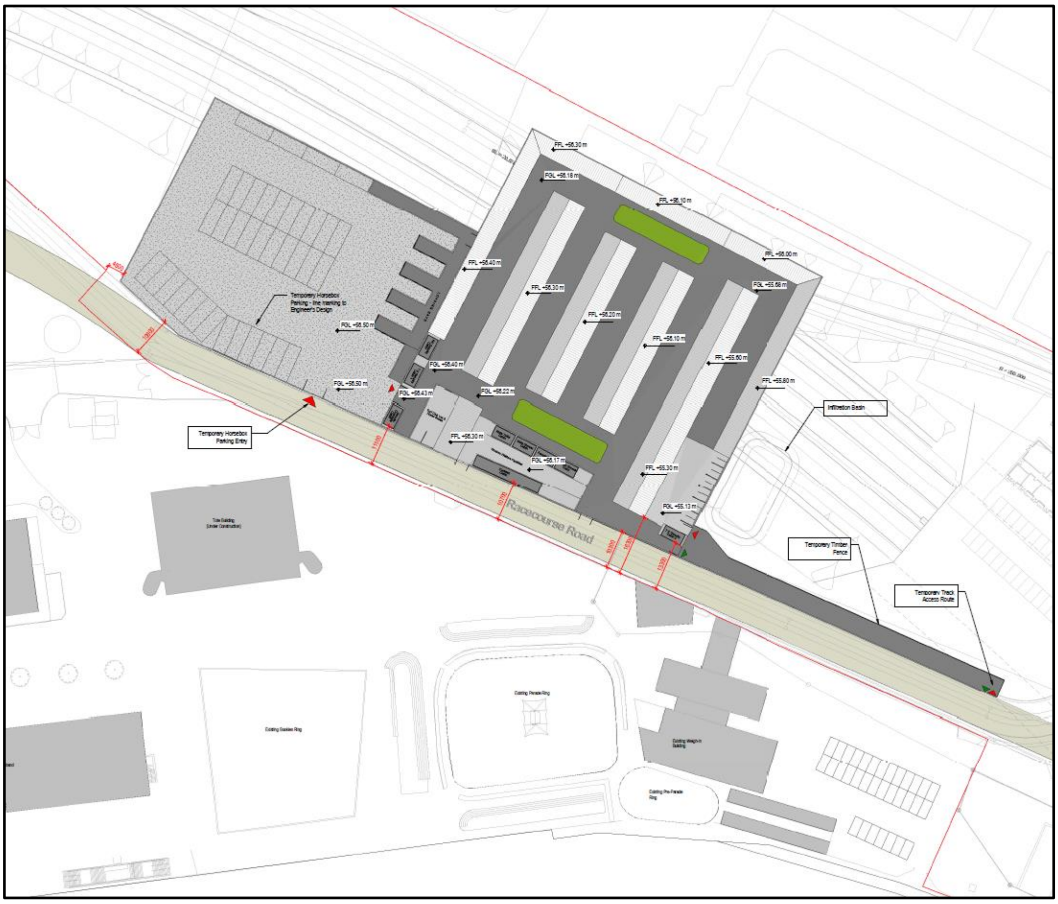
Figure 16.9: Proposed relocation of stable yard (shown shaded in green)



16.2.5 Construction Impacts

The construction envelope of the tunnel overlaps between the existing stable yard and the proposed relocation site therefore it is not possible to construct the new stable yard in advance of demolishing the existing stables. Temporary stables will be required at an alternative location for a period of 2 years in the construction phasing to maintain the operation of a 158 No. stable yard. See **Figure 16.10**.

Figure 16.10: Temporary Stable Yard



It is proposed to the construct the full temporary stable yard in advance of demolishing the existing stables to ensure relevant approvals are received from Irish Horse Racing Board (IHRB). This work can form part of the advance works. It is proposed to use the temporary stable yard for one Summer Festival and two years of smaller festivals in September and October.

With the proposed mitigation it would be possible to partially construct some of the permanent stables outside of the excavation zone to the north in addition to the covered machinery area as part of the advance works also to aid with overall construction and festival sequencing.

The temporary stable yard includes the following;

- 158 No. Stables
- Turf Club Office & Treatment Boxes
- Turf Club Security Offices
- Racecourse Vet Office & Treatment Boxes
- Racecourse Security Offices
- Temporary Horsebox Car Park and associated access roads.

16.2.6 Masterplan

Refer to **Figure 16.11** for details of the permanent stable yard, the masterplan includes;

- 158 No. Stables
- Covered Machinery Area
- 1 No. Maintenance Shed
- Turf Club Office & Treatment Boxes
- Turf Club Security Offices
- Racecourse Vet Office & Treatment Boxes
- Racecourse Security Offices
- Grooms Canteen & Toilets
- Bedding Stores
- Horsebox Car Park and associate access roads

Figure 16.11: Permanent Stable Yard

16.2.7 Architectural Design of Stables

16.2.7.1 Permanent Stables

Details of the design of the permanent proposed stable yard and its associated infrastructure are provided on the Coady Architecture Drawing Series and associated design report provided in **Appendix A.16.1**.

16.2.7.2 Temporary Stables

The design of the temporary stable yard and its associated infrastructure are also provided on the Coady Architecture Drawing Series and the associated design report provided in **Appendix A.16.1**.

16.2.8 Surface Water

Surface water runoff from the proposed stables, buildings, stable yard, associated accesses and walkways will be collected using gullies, downpipes and drainage channels. These will be connected to a series of underground collector drains. The collector drains will discharge via gravity to the IDA storm trunk sewer, located to the east of the Galway Racecourse Tunnel portal.

For the temporary stable yard, surface waters will be disposed of in the temporary scenario using a temporary infiltration basin.

The design of surface water drains is designed in accordance with BS EN 752 Drain and sewer systems outside buildings.

The layout of the proposed surface water drainage network for the permanent stable yard is shown on Drawing **GCOB-3000-D-350** and on Drawing **GCOB-3000-D-351** in **Volume 2** for the temporary stable yard.

16.2.9 Foul and Potable Water

Both foul drainage and potable water supply services are required for the proposed stable yard. Both the existing stable yard and the Brooks site are already serviced by existing connections to both.

Foul discharge from the proposed buildings will be discharged to a network of foul drains located within the access tracks and walkways of the stable yard. Wash down water from the stables will be collected in a series of linear drains located at the edge of the proposed apron to each stable. These linear drains will be connected to the foul collector network. The collector drains will discharge to the existing IDA foul sewer network and will replicate the existing scenario of discharge to this sewer. The existing foul sewer currently connecting to the IDA sewer in the vicinity of the existing stables, which serves the greater racecourse facility will need to be diverted throughout the construction phase to ensure full functionality of the operations of the racecourse.

A temporary connection from the temporary stable yard will be established with the existing foul sewer located within the Galway Racecourse facility in order to discharge temporary foul flows.

The design of foul drains is accordance with Building Regulations 2010 – Drainage and Waste Water Disposal Part H Technical Guidance Document and BS EN 752 Drain and sewer systems outside buildings.

The layout of the proposed foul water drainage network for the permanent stable yard is shown on Drawing **GCOB-3000-D-350** and on Drawing **GCOB-3000-D-351** in **Volume 2** for the temporary stable yard.

As part of the works, the watermain network located within racecourse avenue will be diverted to follow the route of the new racecourse avenue alignment to the north. The existing Racecourse and Brooks potable water connections will be reconnected to this proposed new watermain and the supply will be maintained to the new stable yard through the Brooks connection.

A temporary connection will be established to serve the temporary stableyard from the existing watermain located in the Racecourse Avenue adjacent to the temporary stableyard.

16.2.10 Track Reticulation Water and Storage

Prior to the demolition and removal of Wells W50-13 and W50-14 2 no. new wells to be bored and tested to ensure equivalent yield and water quality of existing wells. The location of these wells to be located to the south of the Galway Racecourse Tunnel. To ensure that the replacement wells provide similar water quality to the original wells, water samples should be taken from the existing wells (pre-treatment) and either demand estimated by Galway Racecourse or short-term pumping test under taken at both existing wells to determine the current abstraction rates. The replacement well can be then compared against the existing wells to ensure yield and quality has not been reduced. A replacement storage tank with a minimum volume equivalent of 100,000 gallons to be provided in combination with pipework and pump station to supply track reticulation system.

A new connection will be established between the existing track watering facility and the new tank location. Refer to drawings **GCOB-300-D-301** for the location of the existing track water system.

16.2.11 Lighting

The proposed lighting for the stable yard will comprise of wall mounted fixtures located beneath the eaves of the proposed stables.

The proposed lighting for the horsebox car park is detailed on Drawing **GCOB-300-D-360** in **Volume 2**.

16.2.12 Vehicle Swept Path Analysis

A vehicle swept path analysis has been carried out at the proposed horse box carparks to ensure sufficient layouts and space has been provided to facilitate turning movements of the required vehicle types. Details of the proposed swept paths can be found on Drawings **GC0B-3000-D-361** to **367** in **Volume 2**.

16.2.13 Landscape and Visual

Soft landscaping has been provided adjacent to the southern verge of the re-aligned section of the Racecourse Avenue. Soft landscaping is also provided to the southern boundary between the horse box carpark and the race track. Details of the proposed landscaping can be found on Drawing **GC0B-3000-D-370** in **Volume 2**.

16.3 Bat Roost Mitigation Design

16.3.1 Introduction

Across the proposed road development, a number of houses, that require demolition to facilitate the construction of the proposed road development, have been identified as confirmed bat roosts. The scheme ecologists have drawn up a mitigation plan to address the impacts on the bat populations. Full details are provided in the EIA Report.

Part of the mitigation strategy involves the creation of a number of artificial bat roosts. These artificial roosts will comprise a permanent replacement structure in locations close to the original bat roosts. Refer to Drawings **GC0B-3000-D-004** to **006** in **Volume 2** for the bat roost locations.

16.3.2 Design of Bat Roosts

The bat roost comprises a structure similar to an agricultural shed. The structure itself will comprise of a rendered block wall with a natural slate roof. The position of the buildings maximises solar gain on the pitched roof and are also situated close to existing vegetation.

Additional special design measures are incorporated into the structure to enhance the space for bats. Some of the measures include for example, protected entry points, open hatches to the attic space, specific plywood partitions in the roof voids to provide “hotboxes”, partitions at ground level to provide separate insulated rooms, earth floors and special configuration of the downpipes from the roof guttering runoff which will allow control of the humidity levels internally.

There are three different sizes of floor areas required for the new construction of bat roosts and there are two existing buildings requiring modifications for different types of bat roosts. Currently there are four new structures proposed as mitigation for bat roosts.

Table 16.1: Bat Roost Summary

Location	Roost Type	Floor Area
Aughnacurra	Maternity / Hibernation Roost	10 x 8 = 80m^2
Menlo Castle	Maternity / Hibernation Roost	10 x 8 = 80m^2
Menlo Woods, Coolough Road	Night Roost	1 x 2 = 2m^2
Ballindooley	Hibernation / Night / Day Roost	8 x 6 = 48m^2
Aille	Retrofitted roost at existing cottage	11.2 x 6.3 = 70.6m^2
Castlegar	Retrofitted roost on existing converted garage	10.9 x 6.8m^2 = 74m^2

Details of the proposed bat roost building layouts are provided on Drawings **GCOB-3000-D-001** and **002** in **Volume 2**.

16.4 Mammal Culverts

A summary of the additional culverts that are required for environmental mitigation purposes are summarised in **Table 16.2**. These comprise of pipe culvert crossings beneath the mainline to facilitate mammal crossing e.g. badgers. These culverts have not been covered in previous chapters as they are not required for hydraulic purposes or subject to Section 50 approval (Refer to **Chapter 8, Drainage, Hydrology & Flood Risk**) nor subject to BD02 approval (Refer to **Chapter 7, Structures**) due to their smaller size requirement.

Table 16.2: Additional Environmental Culverts

GCTP Ref	Ecology Reference	Chainage	X	Y	Diameter (m)	u/s CL (m AOD)	d/s CL (m AOD)	u/s invert (m AOD)	d/s invert (m AOD)	d/s invert (m AOD)	Length
C00/00	MU01	550	521317	723094	0.6	32.033	32.59	30.52	30.25	30.25	30.6
C05/01	MU09	5260	525133	725501	0.6	55.46	55.47	54.07	53.92	53.92	27.2
C07/04	MU17	7650	526928	727122	0.6	67.47	67.22	65.15	65.87	65.87	19.3
C07/01 (b)	MU18	7450	527112	726276	0.6	42.3	42.29	36.5	36.88	36.88	38
C12/01	MU38	12130	531094	728558	0.6	20.19	20.13	18.89	18.83	18.83	23.5
C13/02	MU44	13700	532621	728238	0.6	26.61	26.62	21.27	21.07	21.07	64.1
C06/01b	MU46	6850	526433	726362	0.6	55.74	52.5	54.29	52.5	52.5	64.8
C10/02a	MU51	10725	529693	728389	0.6	13.48	13.55	11.73	11.45	11.45	44.8

17 Conclusions & Recommendations

The key objective in taking the proposed road development to the level of design development, as presented in this Design Report, is to identify a robust proposed road development together with the landtake requirements to build, operate and maintain it. The need for the scheme has been established and is presented fully in the EIA Report. With this key objective in mind the Design Report is a key deliverable of Phase 3 Design and informs Phase 4 EIA/EAR and The Statutory Process.

This Design has been the subject of the TII Peer review process. Following the review, updates to the design were incorporated. The proposed road development caters for forecast Design Year traffic volumes and its delivery will bring about a reduction in the frequency and severity of accidents. The proposed road development has been designed in accordance with applicable standards, best practice guidelines and in accordance with policy documents. The Cost Benefit Analysis has shown that the scheme is economically viable and a worthwhile project to progress.

As Part of Phase 4 EIA/EAR & The Statutory Process, the Motorway Order, Protected Road Order and EIA Report is scheduled for submission to An Bord Pleanala in Q2 2018.

The Design Report documents that all studies and deliverables outlined in the Project Management Guidelines Phase 3 Design have been undertaken and completed. Therefore it is recommended that the proposed road development, as described in this Design Report, be approved by TII in order to inform the basis for the Land Acquisition and Statutory Processes to follow.