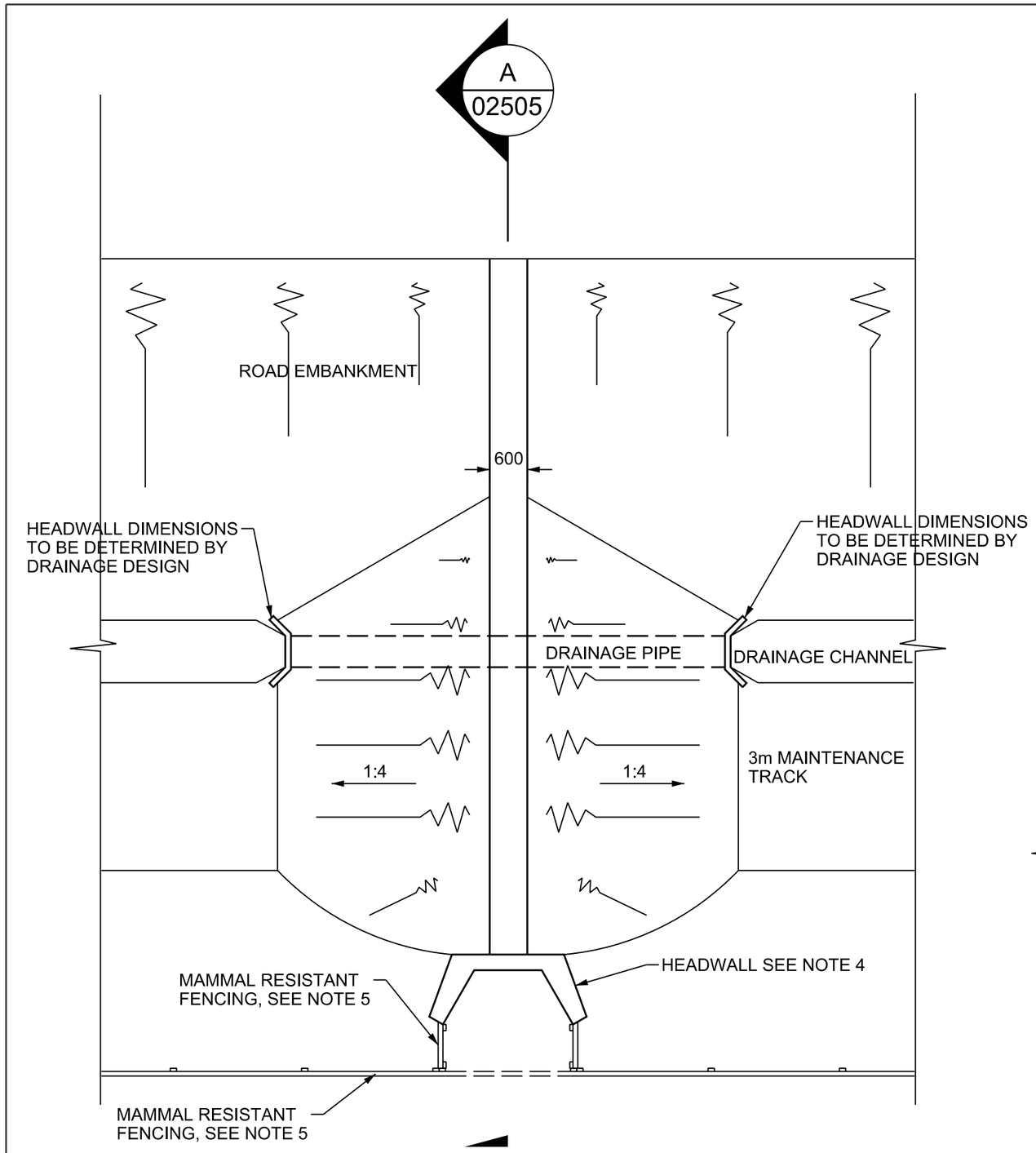
Appendix A

Mammal Passage Facilities

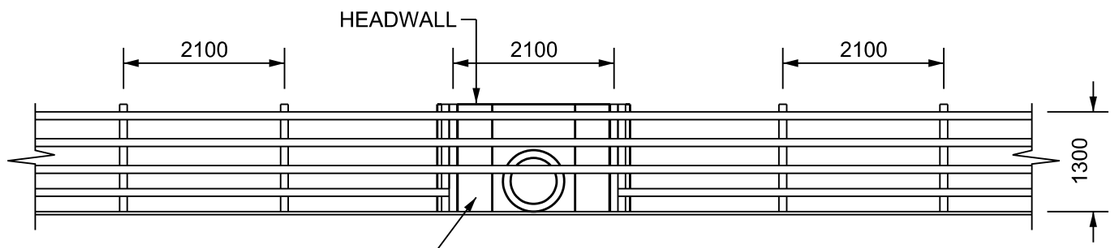
A1



HEADWALL DETAIL PLAN

NOTE :-

1. MAMMAL UNDERPASS SHALL BE 600Ø CONCRETE PIPE CROSSING THROUGHOUT THE ROAD EMBANKMENT.
2. SEE CC-SCD-00319 FOR DETAILED REQUIREMENTS OF MAMMAL RESISTANT FENCING WHICH MUST EXTEND A SUFFICIENT DISTANCE FROM UNDERPASSES TO ENSURE THAT MAMMALS WILL NOT NAVIGATE AROUND THEM.
   THE PROPOSED EXTENT OF FENCING IS SCHEME SPECIFIC AND SHALL BE AGREED WITH THE TII SPECIFICATION PRIOR TO CONSTRUCTION. IT MAY OFTEN BE NECESSARY TO INCORPORATE MAMMAL RESISTANT FENCING ALONG CONTINUOUS LENGTH OF A SCHEME.
3. THIS DRAWING IS AN INDICATIVE (TYPICAL) DETAIL DESIGN/DETAILING OF DRAINAGE. SERVICES AND THE HEADWALL ARE TO BE UNDERTAKEN ON A SCHEME SPECIFIC BASIS.
4. ALL MAMMAL UNDERPASSES SHALL HAVE A FORMED HEADWALL AT EACH END. THE FORMED HEADWALL SHALL BE IN ACCORDANCE WITH CC-SCD-00553, EXCEPT THAT THE WINGWALLS SHALL HAVE THE SAME HEIGHT AS THE HEADWALL.
5. WHERE THE HEADWALL IS SEPARATED FROM THE PERMANENT BOUNDARY, MAMMAL RESISTANT FENCING TO CC-SCD-00319 MUST BE USED TO CONNECT THESE FEATURES SUCH THAT NO GAPS EXIST. WHERE SUCH FENCING IS REQUIRED WITHIN THE CLEAR ZONE OF THE ROAD, TIMBER POST AND TENSION MESH FENCING AS PER CC-SCD-00320. TOGETHER WITH MAMMAL RESISTANT CHAINLINK MESH AND BURIED BELOW GROUND LEVEL AS PER CC-SCD-00319, SHALL BE USED.
6. THE MAMMAL UNDERPASS SHALL RUN IN A STRAIGHT LINE BETWEEN THE HEADWALLS.
7. ALL CONSTRUCTION UNDERPASS AND MAMMAL RESISTANT FENCING SHALL BE CHECKED TO ENSURE THERE ARE NO GAPS OR WEAK POINTS WHICH COULD BE EXPLOITED.



ELEVATION

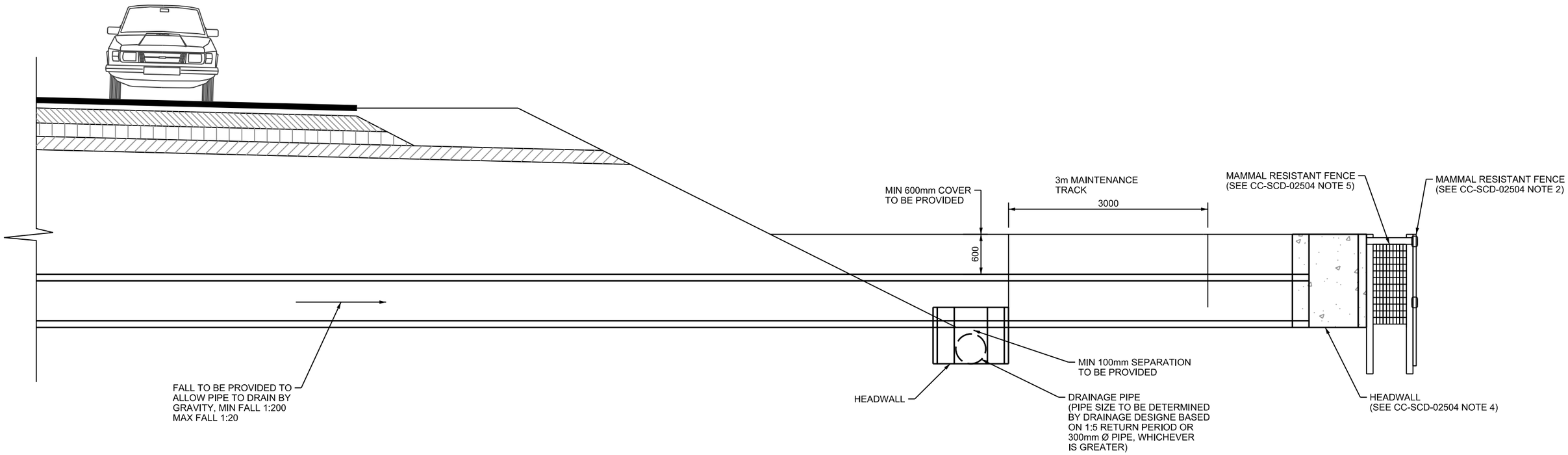
Bonneagar Iompair Éireann
Transport Infrastructure Ireland

ACTIVITY: CC Construction & Commissioning

PUBLICATION TITLE: SPECIAL STRUCTURES
MAMMAL UNDERPASS GENERAL LAYOUT

STREAM	SHEET	HISTORICAL REFERENCE	DOCUMENTATION SET	PUBLICATION DATE	PUBLICATION NUMBER (ACTIVITY / STREAM / DRAWING NUMBER)
STANDARD CONSTRUCTION DETAILS (SCD)	A3	RCD/2500/4	STANDARD	MARCH 2015	CC / SCD / 02504

NOTE:-
1. FOR NOTES REFER TO CC-SCD-02504.



SECTION A

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

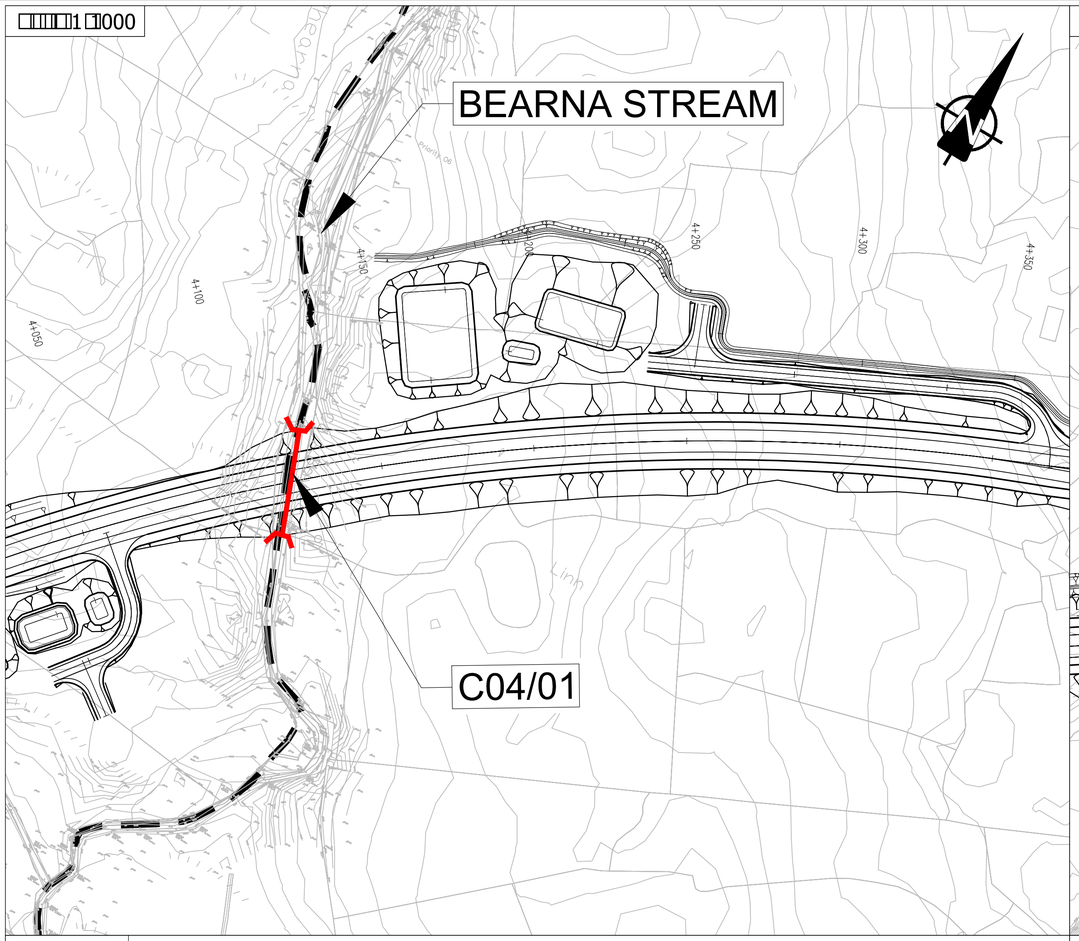
ACTIVITY: CC Construction & Commissioning

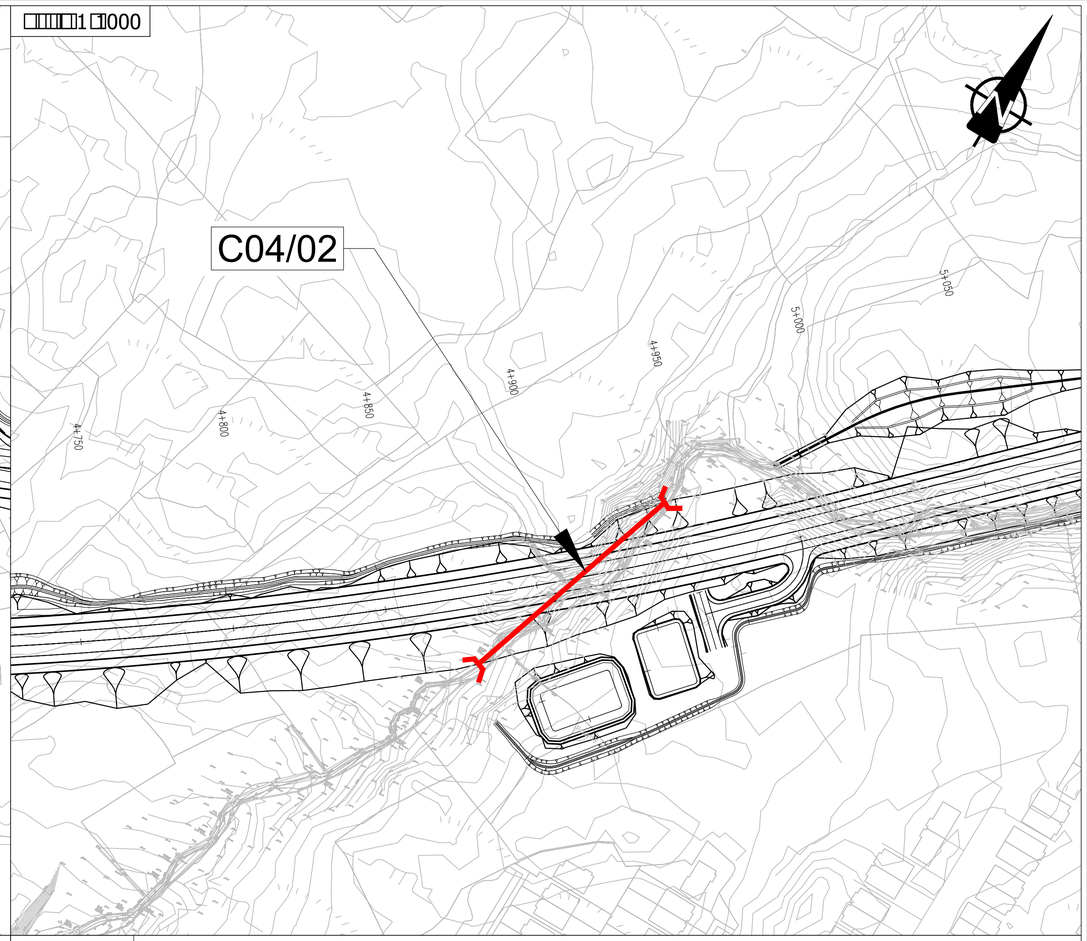
STREAM: STANDARD CONSTRUCTION DETAILS (SCD)

SHEET: A3

PUBLICATION TITLE:
SPECIAL STRUCTURES
MAMMAL UNDERPASS LONG SECTION

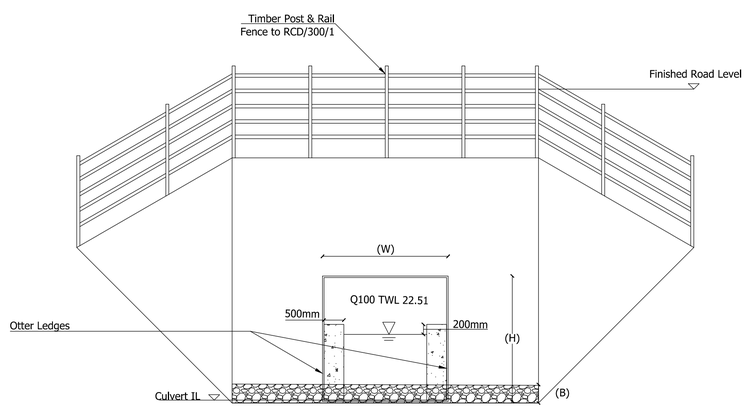
HISTORICAL REFERENCE	DOCUMENTATION SET	PUBLICATION DATE	PUBLICATION NUMBER		
			ACTIVITY	STREAM	DRAWING NUMBER
RCD/2500/5	STANDARD	MARCH 2015	CC	SCD	02505





Legend:

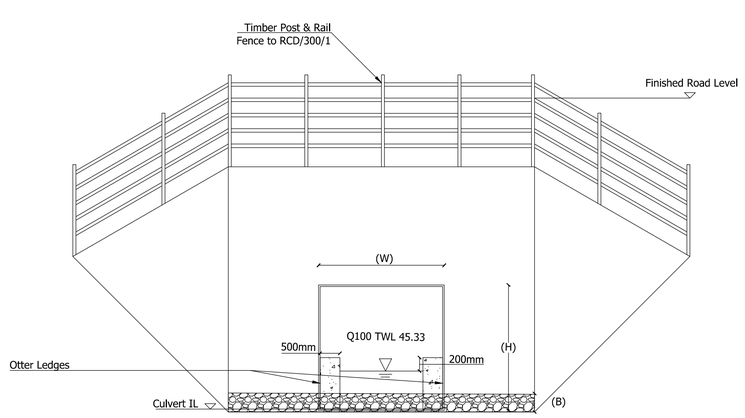
- City Boundary
- Proposed Road Development
- Proposed Culvert
- Proposed Attenuation Pond / Infiltration Basin/ Wetlands



No.	Box Culvert		Length	Buried (B)	Proposed IL Upstream	Existing Bed Level Upstream	Proposed IL Downstream	Existing Bed Level Downstream
	Width (m) (W)	Height (m) (H)	m	m	m	m	m	m
C04/01	5	2.5	34.9	0.3	21.17	21.47	20.69	20.99

Section C04/01

Note: Otter ledges 500mm wide and level set at least 200mm above the Q100 top water level.



No.	Box Culvert		Length	Buried (B)	Proposed IL Upstream	Existing Bed Level Upstream	Proposed IL Downstream	Existing Bed Level Downstream
	Width (m) (W)	Height (m) (H)	m	m	m	m	m	m
C04/02	3.1	2.5	80.4	0.3	44.56	44.86	42.32	42.62

Section C04/02

Clients

An Roinn Iompair Turasóireachta agus Spóirt
Department Transport, Tourism and Sport
Project Ireland 2040 Building Ireland's Future
N6 Galway City Transport Project
Comhairle Chontae na Gaillimhe Galway County Council
TII Bonneagar Iompair Éireann Transport Infrastructure Ireland

Consultant

ARUP

Corporate House
City East Business Park
Ballybrit, Galway, Ireland.

Tel +353 (0)91 460675
www.N6GalwayCity.ie
www.arup.ie

Job Title
N6 Galway City Ring Road

Scale: As Shown
Date: February 2018

Issue	Date	By	Chkd	Appd
I6	09/03/2020	AG	HK	EMC
I5	02/03/2020	KJ	HK	EMC
I4	22/02/2018	KJ	HK	EMC
I3	11/07/2017	PC	HK	EMC
I2	01/07/2016	PC	HK	EMC
I1	03/05/2016	PC	HK	EMC

Drawing Title
Section 50 Application
Culvert Details
Sheet 6 o□9

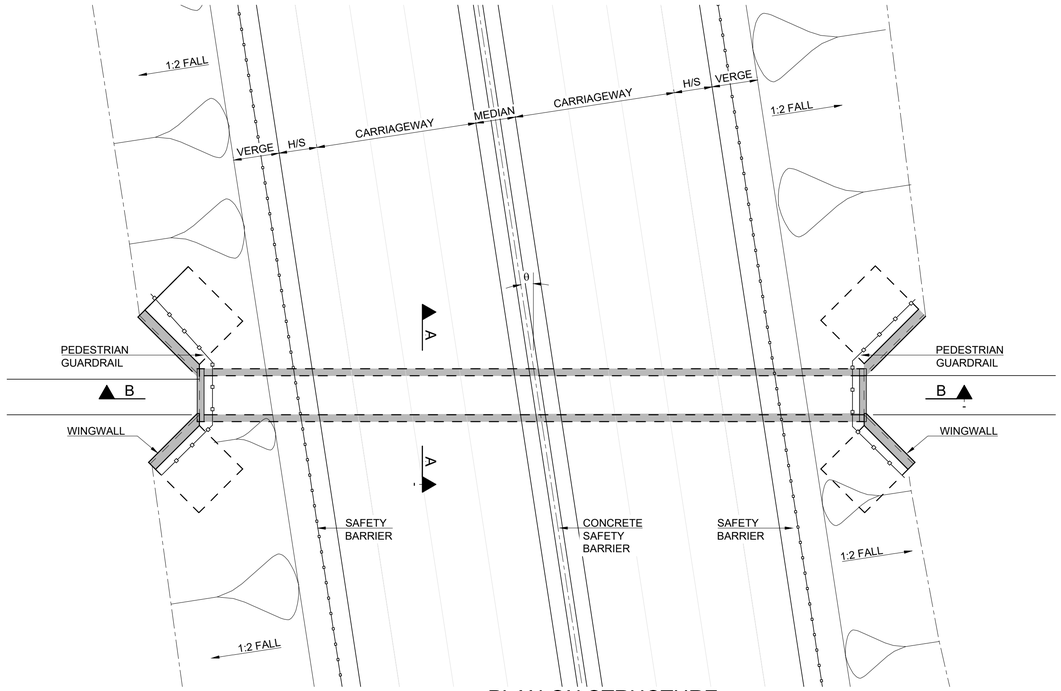
Drawing Status
For Information

Job No	Drawing No	Issue
233985	**GCOB-500-D-520**	**I6**

Do not scale

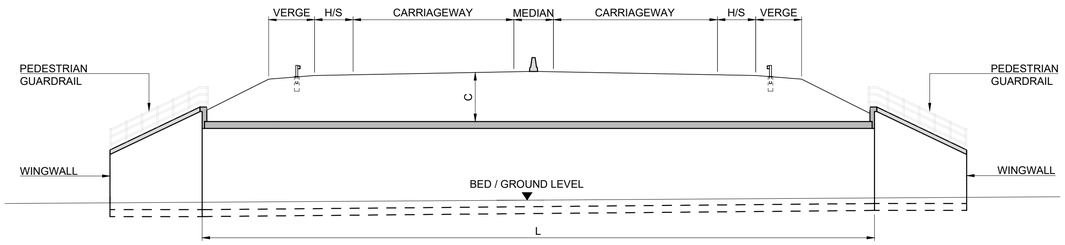
J:\233000\233985-00\4. Internal\4-02 Drawings\4-02-8 Highways\8.3 Design Rep\500 Drainage\GCOB-500-D-515-523.dwg

DESIGN REPORT



PLAN ON STRUCTURE

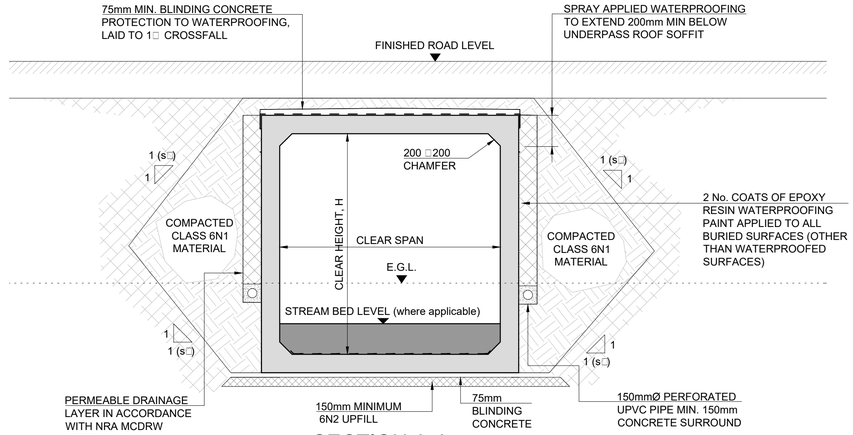
SCALE 1:200



SECTION B-B

SCALE 1:200

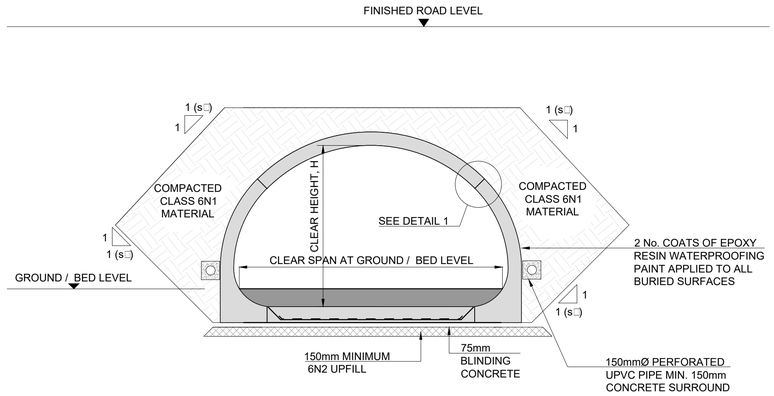
Reference	Name	Chainage	Strucuture Type	Clear Span, S [m]	Length, L [m]	Structural Depth, SD [m]	Clear Height, H [m]	Approximate cover, C (m)	Skew Angle, θ (deg)
C00/01	Culvert C00/01	00+670	Buried RC box	2.5	95.0	0.25	1.35	2.2	65
C02/01a	Culvert C02/01a - Tusky Stream	02+800	Buried RC box	2.1	38.0	0.25	1.80	2.6	16
C02/01b	Culvert C02/01b - Tusky Stream	02+850	Buried RC box	2.5	78.0	0.25	2.50	2.7	30
C03/01	Culvert C03/01	03+070	Buried RC box	2.5	48.0	0.25	1.20	0.6	4
C03/04	Culvert C03/04	03+965	Buried RC box	2.5	55.0	0.25	1.20	2.9	19
C03/03	Culvert C03/03	03+945	Buried RC bo□	2.5	52.0	0.25	1.20	3.1	19
C04/01	Culvert C04/01 - Bearna Stream	04+120	Buried RC bo□	5.0	35.0	0.35	2.50	0.9	15
C04/02	Culvert C04/02	04+915	Buried RC bo□	3.1	82.0	0.25	2.50	1.7	59
C06/00	Culvert C06/00	06+450	Buried RC bo□	2.5	64.0	0.25	2.50	4.2	31
C06/01	Culvert C06/01	06+850	Buried RC box	2.5	64.0	0.25	2.50	3.6	53
C07/00	Culvert C07/00	07+100	Buried RC box	2.5	59.0	0.25	2.00	1.6	11
C07/02a	Culvert C07/02a	07+225	Buried RC arch	2.5	101.0	0.25	2.50	7.7	0
C08/01a	Culvert C08/01a	08+450	Buried RC box	2.5	52.0	0.25	2.50	4.3	0
C08/02	Culvert C08/02	08+650	Buried RC box	2.5	37.0	0.25	2.50	1.9	0
C08/04	Culvert C08/04	08+580	Buried RC box	2.5	46.0	0.25	2.50	4.6	0
C08/05	Culvert C08/05	08+620	Buried RC box	2.5	42.0	0.25	2.50	2.7	0
C09/06	Culvert C09/06	09+790	Buried RC arch	2.5	80.0	0.25	2.50	10.9	0
C09/07	Culvert C09/07	09+920	Buried RC arch	2.5	70.0	0.25	2.50	14.2	0
C12/02	Culvert C12/02	12+375	Buried RC arch	2.5	117.0	0.25	2.50	12.6	0
C12/03	Culvert C12/03	12+410	Buried RC arch	2.5	108.0	0.25	2.50	10.5	0
C12/04	Culvert C12/04	12+435	Buried RC arch	2.5	96.0	0.25	2.50	8.8	0
C13/01	Culvert C13/01	12+980	Buried RC box	2.5	57.0	0.25	1.50	3.9	0



SECTION A-A

SCALE 1:50

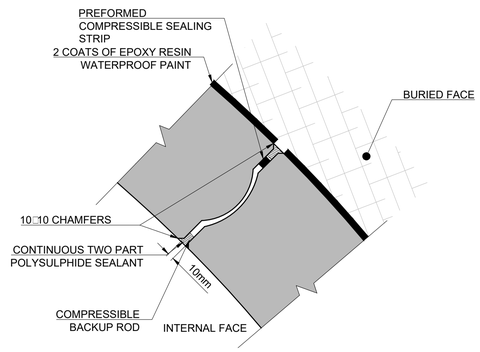
BURIED BOX



SECTION A-A

SCALE 1:50

BURIED ARCH



DETAIL 1

SCALE 1:5

NOTES:

1. ALL DIMENSIONS ARE SHOWN IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE SHOWN IN METRES ABOVE ORDNANCE DATUM.

Clients: Comhairle Chontae na Gaillimhe Galway County Council; N6 Galway City Transport Project; An Roinn Iompair Turasóireachta agus Spóirt Department Transport, Tourism and Sport; TII Transport Infrastructure Ireland

Consultant
ARUP
Corporate House
City East Business Park
Ballybrit, Galway, Ireland.
Tel +353 (0)91 460675
www.N6GalwayCity.ie
www.arup.ie

Job Title: N6 Galway City Ring Road

Scale: AS SHOWN @ A1

Date: July 2016

Issue	Date	By	Chkd	Appd
I3	02/08/2017	LM	PM	EMC
I2	30/06/2017	LM	PM	EMC
I1	11/07/2016	PD	PM	EMC

Drawing Title: Culverts □ Underpasses Buried Bo□and Arch Structures

Drawing Status: **For Information**

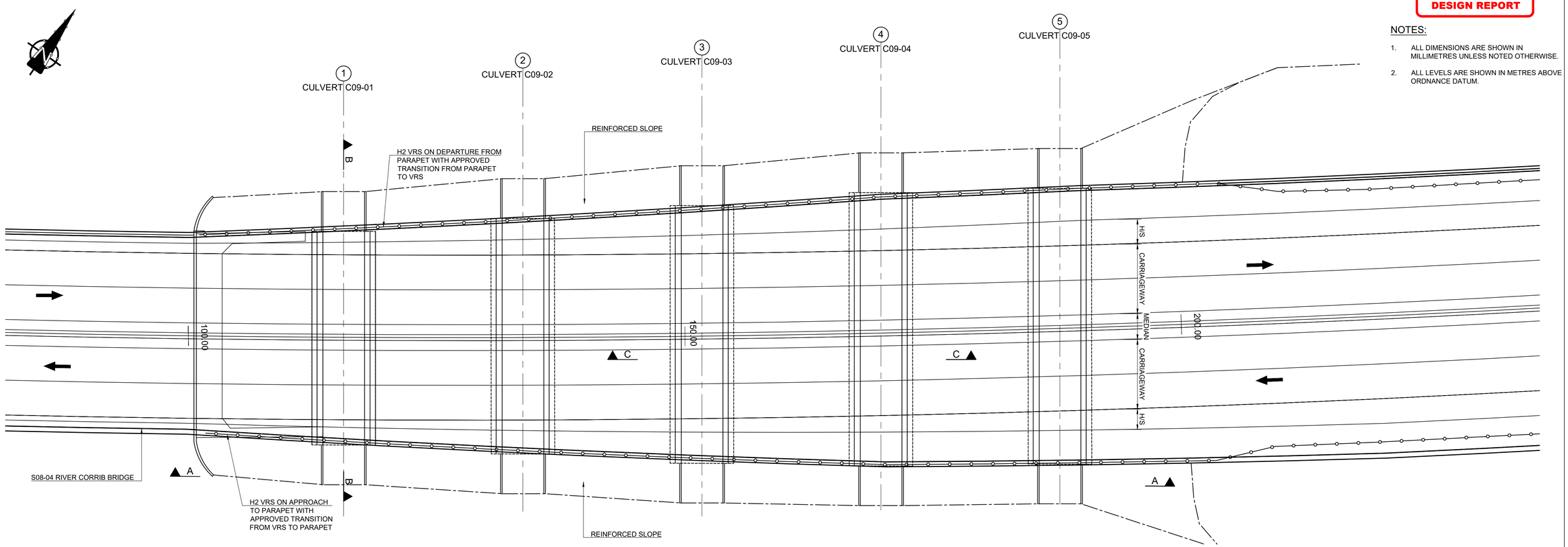
Job No	Drawing No	Issue
233985	GCOB-1700-D-GEN-011	I3

Do not scale

DESIGN REPORT

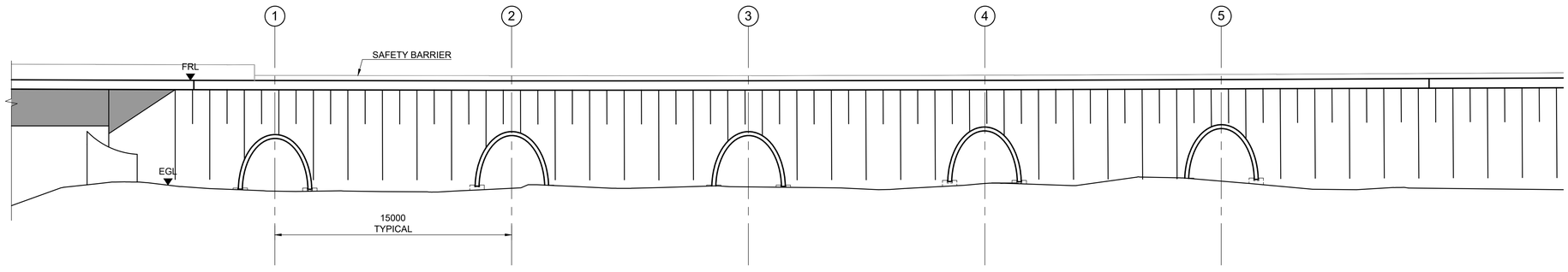
NOTES:

1. ALL DIMENSIONS ARE SHOWN IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE SHOWN IN METRES ABOVE ORDNANCE DATUM.



PLAN ON CULVERTS

SCALE: 1:200



ELEVATION A-A

SCALE: 1:200

Clients: Comhairle Chontae na Gaillimhe Galway County Council; N6 Galway City Transport Project; An Roinn Iompair Turasóireachta agus Spóirt Department Transport, Tourism and Sport; TII Bonneagar Iompair Éireann Transport Infrastructure Ireland

Consultant: ARUP
Corporate House
City East Business Park
Ballybrit, Galway, Ireland.
Tel +353 (0)91 460675
www.N6GalwayCity.ie
www.arup.ie

Job Title: N6 Galway City Ring Road

Scale: AS SHOWN @ A1
Date: June 2017

Issue	Date	By	Chkd	Appd
I2	17/10/2017	LM	PM	MS
I1	1/06/2017	LM	PM	MS

Drawing Title: Culverts and Underpasses Structure C09-01 to 05 Sheet 1

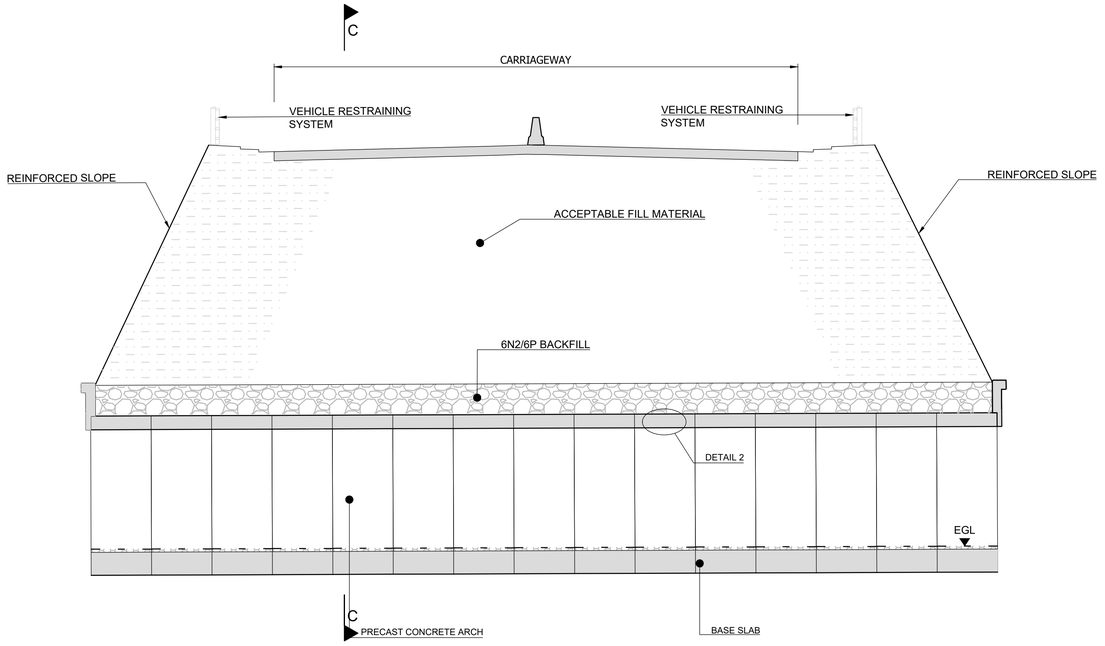
Drawing Status: **For Information**

Job No	Drawing No	Issue
233985	**GCOB-D-ST-C09-1 to 5-001**	**I2**

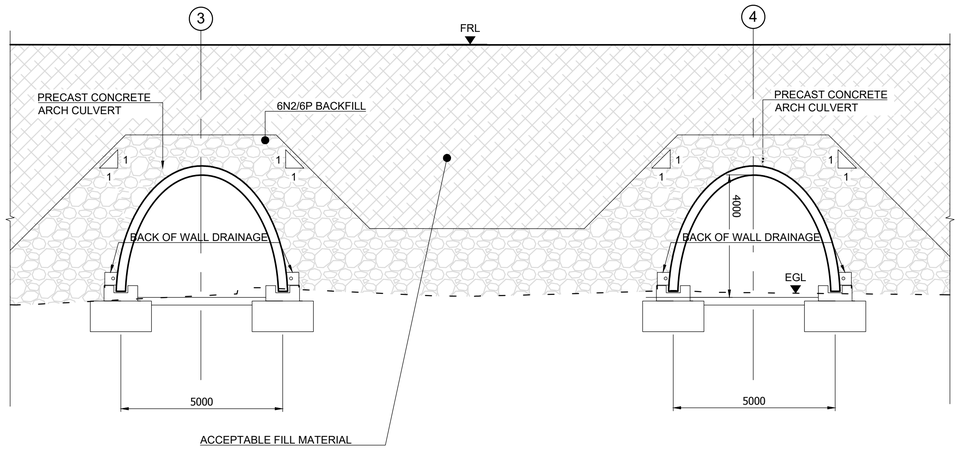
Do not scale

DESIGN REPORT

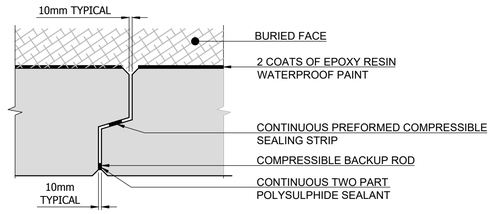
NOTES:
1. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE SHOWN IN METERS ABOVE ADVANCE DATUM.



SECTION B-B
SCALE: 1:100



TYPICAL SECTION C-C
SCALE: 1:100



DETAIL 2
SCALE: 1:10

Clients
Comhairle Chontae na Gaillimhe Galway County Council
N6 Galway City Transport Project
An Roinn Iompair Turasóireachta agus Spóirt Department Transport, Tourism and Sport
TII Transport Infrastructure Ireland

Consultant
ARUP
Corporate House
City East Business Park
Ballybrit, Galway, Ireland.
Tel +353 (0)91 460675
www.N6GalwayCity.ie
www.arup.ie

Job Title
N6 Galway City Ring Road

Scale: AS SHOWN @ A1
Date: June 2017

Issue	Date	By	Chkd	Appd
I2	17/10/2017	LM	PM	MS
I1	01/06/2017	LM	PM	MS

Drawing Title
Culverts and Underpasses
Structure C09-01 to 05
Sheet 2

Drawing Status
For Information

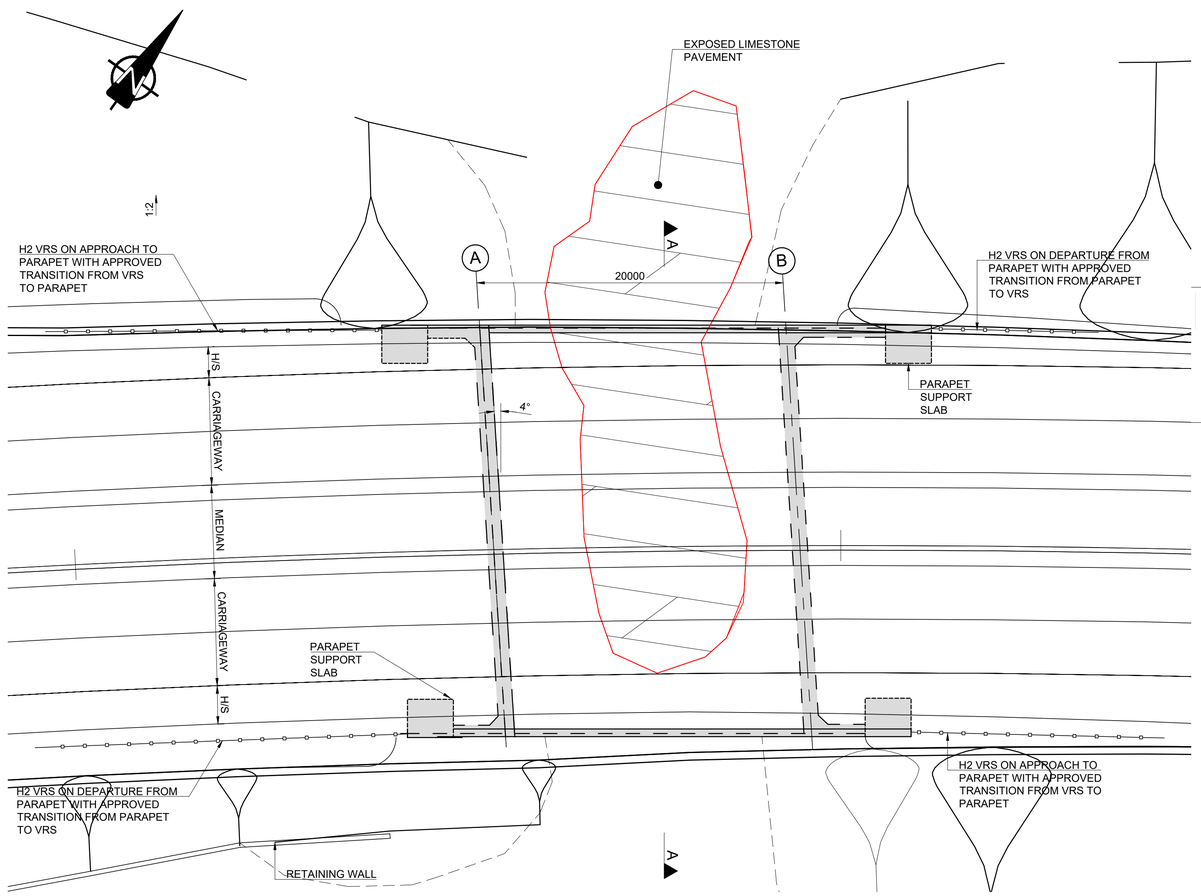
Job No	Drawing No	Issue
233985	GCOB-1700-D-C09-1 to 5-002	I2

Do not scale

DESIGN REPORT

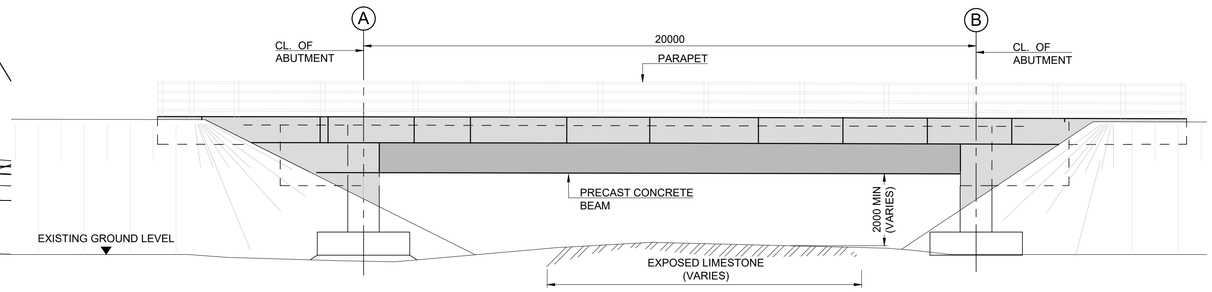
NOTES:

1. ALL DIMENSIONS ARE SHOWN IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE SHOWN IN METRES ABOVE ORDNANCE DATUM.



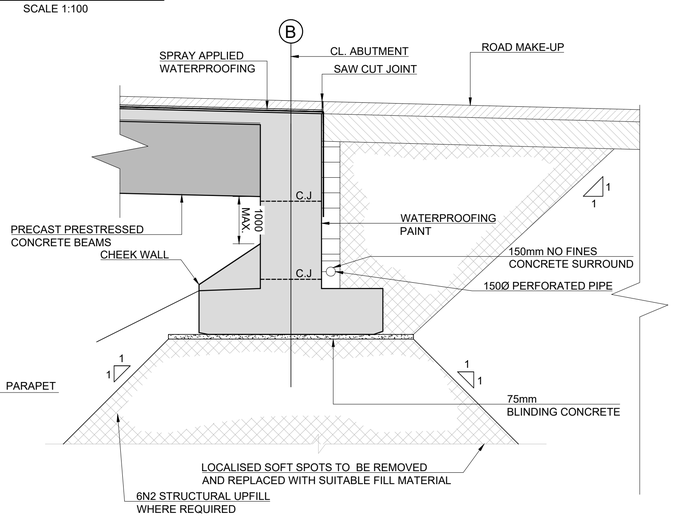
PLAN ON BRIDGE

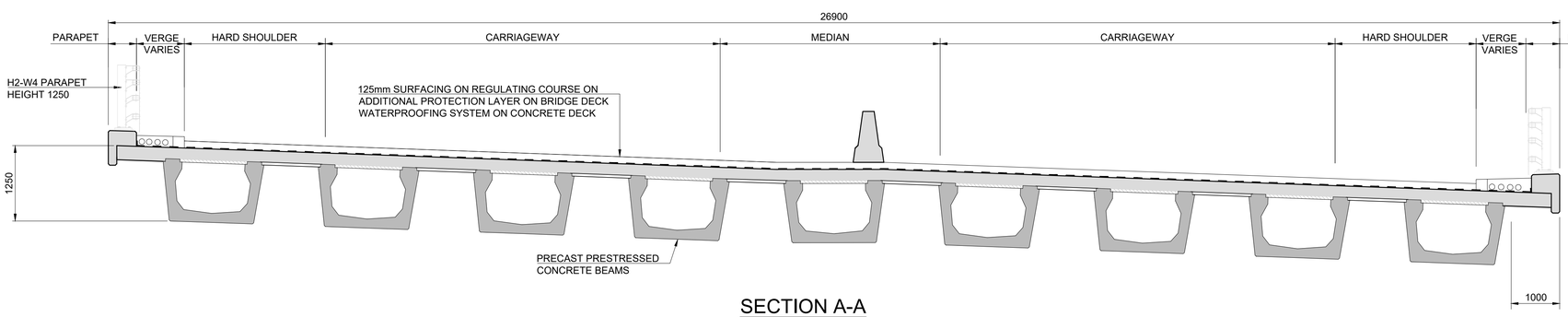
SCALE 1:200



TYPICAL ELEVATION

SCALE 1:100





SECTION A-A

SCALE: 1:50

TYPICAL WEST ABUMENT CROSS SECTION

SCALE 1:50

Clients: Comhairle Chontae na Gaillimhe Galway County Council; N6 Galway City Transport Project; An Roinn Iompair Turasóireachta agus Spóirt Department Transport, Tourism and Sport; TII Transport Infrastructure Ireland

Consultant: ARUP
Corporate House, City East Business Park, Ballybrit, Galway, Ireland.
Tel +353 (0)91 460675
www.N6GalwayCity.ie
www.arup.ie

Job Title: N6 Galway City Ring Road

Scale: AS SHOWN @ A1
Date: July 2016

Issue	Date	By	Chkd	Appd
I2	30/06/2017	LM	PM	EMC
I1	11/07/2016	PD	PM	EMC

Drawing Title: Culverts and Underpasses: Structure C10/01

Drawing Status: **For Information**

Job No	Drawing No	Issue
233985	GCOB-1700-D-C10-01-001	I2

Do not scale

Appendix B

Guidance Documents for Otters and Badgers

B1 Otters

GUIDELINES FOR THE TREATMENT OF OTTERS PRIOR TO THE CONSTRUCTION OF NATIONAL ROAD SCHEMES

NRA
National Roads Authority
An tÚdarás um Bóithre Náisiúnta

NRA
National Roads Authority
An tÚdarás um Bóithre Náisiúnta

National Roads Authority
St Martin's House, Waterloo Road, Dublin 4
Tel: **01 6602511**
Web: **www.nra.ie**

This document was prepared by: Dr. Chris Smal, Ecological Solutions, 64 The Grove, Greystones, Co. Wicklow.

Photographs and figures in text provided by Dr. Chris Smal and Richard Mills.

GUIDELINES FOR
THE TREATMENT OF OTTERS
PRIOR TO THE CONSTRUCTION
OF NATIONAL ROAD SCHEMES

ENVIRONMENTAL SERIES ON CONSTRUCTION IMPACTS

GUIDELINES FOR THE TREATMENT OF OTTERS PRIOR TO THE CONSTRUCTION OF NATIONAL ROAD SCHEMES

INDEX

INTRODUCTION

The Eurasian otter *(Lutra lutra)* is relatively common and ubiquitous on rivers and streams in Ireland but the species has suffered a decline in numbers in many parts of Europe. Its protection in Ireland is an issue of considerable conservation importance.

The otter is one of the larger members of the Mustelid family of mammals, which, in Ireland, also includes badgers, Irish stoats, pine martens and the introduced American mink. It occurs on most Irish watercourses, lakes, marshes, coasts, and on many offshore islands. It is carnivorous, feeding principally on fish and crustaceans, including crayfish and crabs, whilst occasionally taking other prey, such as frogs, small mammals, and waterfowl.

Many watercourses or areas of open water serve as foraging habitat or as wildlife corridors for otters. They are often present within urban areas - along canals or rivers that pass through many Irish towns. Whilst the otter may occasionally travel overland and will cross farmland, bogs or upland areas, it generally confines its movements close to waterways, lakes or wetlands. Otters are common along many of Ireland's coasts also, but they do need access to fresh water nearby to wash saltwater from their fur.

Each adult otter has its own home range, which it marks with its faeces (spraints) at prominent locations. When groups of otters are evident, they usually consist of a female and her young. Range sizes vary widely according to the quality of the foraging habitat and other resources, such as suitable sites for otter dens (holts). Their ranges may alter seasonally to include sites of abundant prey. The average distribution density of otters is approximately one otter per 10 km on many Irish watercourses, but this will vary from as little as one otter per 50 km of river to, perhaps, as much as one otter per 2 km of river or coastline.

Otters occasionally dig out their own burrows but, more commonly, they make use of existing cavities as resting places or for breeding sites. Holts are often situated within eroded riverbanks, under trees alongside rivers, under fallen trees, within rock piles, or even within dry drainage pipes or culverts, etc. In peaty upland or coastal areas, larger holts may consist of a more complex tunnel and chamber system similar to that of a badger sett. Otters often lie out above ground, especially on small islands or within reed beds, making use of available vegetation to create bedding shaped into small 'couches'. Holts and couches used by breeding females are often in secluded areas away from the main river or waterbody.

Otter births occur predominately between May and August but otter cubs may be born at any time of year. There are usually two or three cubs in each litter and cubs are reared over a period of approximately 6 to 12 months.

Bridges are very commonly marked by otters, with spraints deposited on ledges or on prominent rocks within the watercourse (as in this illustration).

IMPACT OF ROAD SCHEMES

Whilst otters may be widespread in Ireland, they usually exhibit a low-density distribution. Their populations are, therefore, susceptible to habitat fragmentation and, in particular, to mortalities on existing or new roads. Where the provision of access under roads at rivers and streams crossings is inadequate, otters will often endeavour to cross roads. In the UK, road casualties have been observed to peak during November and December and again in March and April.

Given the linear shape and substantial extent of otter home ranges, the loss of small portions of aquatic habitat (e.g. streams, rivers, ponds, etc.) associated with the construction of national road schemes will not usually impact significantly on the overall area and quality of otter habitat. However, where a scheme results in a loss of access to important portions of their foraging habitat, such loss can lead to a decline in breeding success and a diminution of otter numbers in the locality.

Otter holts and couches are not frequently encountered. However, wherever occupied holts are directly impacted, construction works can cause the mortality of adult otters or cubs. Construction works can also cause indirect impacts (through disturbance) to breeding holts close to a planned road scheme.

Construction operations can, sometimes, cause diminution in water quality either through pollution or sedimentation incidents. Whilst such impacts can result negatively on habitat quality, such impacts are usually temporary in nature.

A coastal otter holt, within a small cave on a rocky shore.

LEGISLATION FOR THE PROTECTION OF OTTERS

Otters, along with their breeding and resting places, are protected under the provisions of the Wildlife Act, 1976, as amended by the Wildlife (Amendment) Act, 2000. Otters have additional protection because of their inclusion in Annex II and Annex IV of the Habitats Directive, which is transposed into Irish law in the European Communities (Natural Habitats) Regulations (S.I. 94 of 1997), as amended.

Otters are also listed as requiring strict protection in Appendix II of the Berne Convention on the Conservation of European Wildlife and Natural Habitats and are included in the Convention on International Trade of Endangered Species (CITES). Many of Ireland's rivers, lakes, canals, and coastal areas, provide good habitat for otters in Ireland: such areas include wildlife conservation areas (designated as Natural Heritage Areas or Special Areas of Conservation).

It is important that best practice mitigation measures are put in place to ensure that otters, and their populations, are not impacted during the construction and operation of national road schemes. Normally, such measures will require the provision of adequately designed culverts and bridges that allow for the free passage of otters. In addition, mammal-resistant fencing either side of these crossings is usually recommended at watercourse crossings used by otters. Otters may need to be evacuated from affected holts and, where necessary, alternative (artificial) holts will need to be created.

The removal of otters from affected holts, and the subsequent destruction of these holts, must be conducted under a Section 25 derogation under the 1997 Habitats Regulations. The National Parks and Wildlife Service (NPWS), of the Department of the Environment, Heritage and Local Government, is responsible for processing these licenses. An application for a Section 25 derogation should be submitted to the NPWS along with the relevant ecological information from otter surveys. At least three weeks is normally required to process a derogation application. Conditions will usually be attached to each derogation granted in respect of otters and operations at holts or in their vicinity. Closure of holts requires a monitoring period to ensure that there is no current otter activity at the holt. Derogations may not be provided by the NPWS for the closure of holts containing a breeding female or young otters. Derogations are also required for any works likely to cause disturbance (e.g. piling and blasting) to active breeding holts (when present within c.150m of a scheme).

It should be noted that all activity related to otter surveys, evacuation procedures, and holt destruction should only be undertaken by personnel with adequate expertise in otter ecology.

Many of Ireland's rivers, lakes, canals, and coastal areas, provide good habitat for otters in Ireland.

PRE-CONSTRUCTION OTTER SURVEYS

Holts and otter activity on affected rivers, streams, and other waterbodies, as well as mitigation measures relevant to otters, will already have been reported within the Environmental Impact Statement (EIS) for the respective scheme. At pre-construction stage, additional otter surveys will usually be required, and will often be undertaken at the same time as pre-construction surveys in relation to badgers. There are no seasonal constraints for otter survey, but any dense vegetation (especially in summer) can reduce success in the identification of otter holts or couches.

Pre-construction otter surveys should be undertaken prior to the commencement of any works in order to identify any changes in otter activity, holt locations, etc., since the original EIS surveys. This will ensure that the prescribed mitigation measures in the EIS remain adequate to address possible impacts on otters. It is also important to ensure that no new holts have been created in the intervening period.

The pre-construction survey should be conducted no more than 10-12 months in advance of construction. This will ensure that there will be sufficient time to comply with all licensing requirements and that the necessary actions can be undertaken to protect otter populations prior to the commencement of construction.

The pre-construction survey will aim to ensure that adequate mitigation is provided at each watercourse crossing (or other habitat of value to otters) affected by the scheme. Where necessary, there may be a need to modify the number of, and the design of, culverts and bridges and to adjust the extent of mammal fencing required to protect otters at locations used by otters.

The survey should be supplemented by a further inspection of the development area, immediately prior to site clearance, to ensure that no new holts have been created in the intervening period and to check if any of the previously identified holts are in active use by breeding females or have otter cubs present.

Where more than 36 months has elapsed between the time of a statutory approval of a road scheme and the initiation of the construction phase, an appropriate level of resurvey will be required - because the baseline data may have altered during the intervening period. This will allow adjustments to be made to the mitigation strategy specified in the EIS, where appropriate.

An active otter holt below the roots of a large tree. The slide leads to the river situated close by.

Any dense vegetation (especially in summer) can reduce success in the identification of otter holts or couches.

EXCLUSION OF OTTERS FROM DEVELOPMENT SITES

Otters are likely to be present on most watercourses in Ireland and their home ranges are often large. While it may be possible to exclude otters from their holts, it is very difficult to exclude them entirely from a development site. Adequate mitigation measures will ensure that impacts on watercourses are limited during the construction phase and that severance of otter home ranges, resulting from any road scheme is only temporary.

The detailed provisions for the excavation and destruction of an otter holt will vary according to the nature of otter activity observed at the affected holt.

EXCLUSION PROCEDURES IN RELATION TO OTTER HOLTS

On occasion, otter holts may be directly affected by the scheme. To ensure the welfare of otters, they must be evacuated from any holts present prior to any construction works commencing.

For otter holts that may be located near the fenceline, the treatment of otter holts should acknowledge that there may be other developments in the vicinity. Careful communication with the relevant parties outside the fenceline of the scheme is required to prevent conflicting timing of construction works

The Environmental Impact Statement may, sometimes, prescribe that, as mitigation, an artificial otter holt be constructed to replace the loss of an otter breeding holt. Surveys at pre-construction stage may also advise that artificial otter holts, in addition to any mitigation measures outlined the EIS, be constructed. It must be noted that the recommendation of such a requirement at later stages creates numerous difficulties - which may include the need to purchase suitable land by agreement. Emphasis should therefore be given at EIS and Preliminary Design stages to including otter holt areas, adjacent to the proposed scheme and within lands being compulsorily acquired, so that otters may be afforded adequate mitigation.

Where destruction of holts is unavoidable, a series of procedures is advised - these are similar to those advised for evacuation and removal of badger setts (refer *Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes*, National Roads Authority, 2005). The detailed provisions for the evacuation and destruction of an otter holt will vary according to the nature of otter activity observed at the affected holt.

Otter breeding may take place at any season of the year, so breeding activity at holts will need to be determined on a case by case basis.

DISUSED AND INACTIVE HOLTS

Exclusion of otters from disused, or currently inactive, holts within the landtake for a road scheme may be entertained during any season. Confirming that a holt is inactive will usually require a period of monitoring (e.g. five or more days of checking activity at the holt either with sticks or with sand pads to identify footprints). Where holts have been verified as inactive, and to prevent their reoccupation, the entrances may be lightly blocked with vegetation and a light application of soil (soft blocking). If the entrances remain undisturbed for five days, the holt may then be destroyed immediately using a mechanical digger, under the supervision of the holder of the NPWS derogation.

ACTIVE HOLTS

Otters do not tolerate disturbance at or near holts that are in active use by them. To evacuate otters from non-breeding holts, general disturbance (e.g. vegetation clearance) and use of approved chemical deterrents is recommended. After a period of monitoring (as above), the holt entrances may be lightly blocked - as for inactive holts.

Should there be any delay in holt destruction, the soft blocked entrances (if remaining inactive) should be hard-blocked and the holt then destroyed as soon as possible, again under the supervision of the licensee. Hard-blocking is best achieved using buried fencing materials and compacted soil with further fencing materials laid across and firmly fixed to blocked entrances and surrounds.

Whilst the use of one-way gates is normally a procedure adopted in relation to the exclusion of badgers from setts, and not a standard procedure for the exclusion of otters from holts, this method may be used, in some circumstances, with gates being left in place for a period of 21 days as advised in relation to badgers.

However, where breeding females or cubs are present, it is imperative that no evacuation procedures of any kind should be undertaken until the otters have vacated the holt (this will be established by the otter surveyor undertaking otter monitoring operations).

Otter breeding may take place at any season of the year, so breeding activity at holts will need to be determined on a case by case basis. The period over which pregnant females and cubs are present in a holt can be up to 21 or more weeks. The gestation period is nine weeks and the cubs remain inside the holt for about seven weeks before venturing into the open. The cubs are weaned when aged three to four months.

Once the female and her cubs have vacated the breeding holt, the holt should be monitored and the otters then permanently excluded from the holt following the procedures already outlined.

DESTRUCTION OF HOLTS

Consideration should always be given to the possibility of otters remaining within a holt where its destruction is planned. Suitable equipment should be available on hand to deal with otters present within the holt or any otters injured during destruction of the holt. Destruction of a holt would usually be undertaken with a tracked 12-25 tonne digger, commencing at c. 15m from outer holt entrances and working towards the centre of the holt. Exposed tunnels should be checked for recent otter activity with a view to ensuring the safety of any otters potentially remaining. Once it is ensured that no otters are present, the remainder of the holt may then be destroyed and the entire area back-filled and made safe. Excavation of an otter holt will rarely require more than one working day. A report detailing evacuation procedures, holt excavation and destruction, and any other relevant issues, should be submitted to NPWS, in fulfilment of usual derogation conditions. Construction activities within the vicinity of directly impacted holts may commence once they have been evacuated and destroyed under derogation.

Suitable equipment should be available on hand to deal with otters present within the holt or any otters injured during destruction of the holt.

GUIDELINES FOR SITE WORKS IN THE VICINITY OF ACTIVE OTTER HOLTS

Until such time as otters have been successfully evacuated from active holts, the following provisions should apply to all construction works:

- No works should be undertaken within 150m of any holts at which breeding females or cubs are present. Following consultation with NPWS, works closer to such breeding holts may take place - provided appropriate mitigation measures are in place, e.g. screening and/or restricted working hours on site.
- No wheeled or tracked vehicles (of any kind) should be used within 20m of active, but non-breeding, otter holts. Light work, such as digging by hand or scrub clearance should also not take place within 15m of such holts, except under licence.
- The prohibited working area associated with otter holts should, where appropriate, be fenced with temporary fencing prior to any possibly invasive works. Fencing should be in accordance with Clause 303 of the NRA's *Specification for Roadworks* (National Roads Authority). Appropriate awareness of the purpose of the enclosure should be conveyed through notification to site staff and sufficient signage should be placed on each exclusion fence.
  All contractors or operators on site should be made fully aware of the procedures pertaining to each affected holt.
- Where holts are present in close proximity to invasive construction works but are determined not to require destruction, construction works may commence once recommended alternative mitigation measures to address otters have been complied with.

No works should be undertaken within 150m of any holts at which breeding females or cubs are present.

WATER CROSSINGS

The welfare of otters on road schemes in Ireland will be ensured mainly by the provision of continued safe access for otters to their ranges and foraging habitats.

Otters use rivers, streams, and small drains, as corridors of access to their home ranges. Adequate provision for otters at affected watercourse crossings is required to allow the species to retain continued access to their foraging areas. The spanning of larger rivers or larger watercourses normally results in only limited disruption to otter activity. Attention has to be paid to crossings over smaller watercourses.

Ledges will be required at watercourse crossings used by otters. Where ledges cannot be provided, other mammal underpasses might be substituted. In most instances, provisions for otters at watercourse crossings will usually serve for badgers and other mammalian species also (provisions such as ledges, underpasses, fencing etc.).

Where badger-resistant fencing has been recommended to restrict movement of badgers across a road scheme, this will also serve to keep otters from crossing the road scheme. Otters will often cross roads even where there appears to be more than adequate access provided within the watercourse by a well-designed bridge or culvert. The erection of wildlife fencing (to ensure that otters use the watercourse rather than attempting to cross the road) is, therefore, always recommended, see mammal fencing on page 12.

Watercourses provide important habitat for many floral and faunal species. The correct treatment of watercourses is an important element of planning of road schemes in Ireland (refer to the *Guidelines for the Crossing of Watercourse during the Construction of National Road Schemes*, National Roads Authority, 2005). These guidelines detail best practice at larger watercourse crossings and will provide, in most instances, adequate mitigation for otters. However, otter surveys at EIS or pre-construction stage may reveal that smaller streams and drains are also being used as wildlife corridors by otters. The overall mitigation requirements for otters affected by a road scheme will then need to include additional provision for otters at these locations. Such measures might include construction of a box culvert, with ledges for otters, rather than a pipe culvert, for example.

Watercourses provide important habitat for many floral and faunal species.

CULVERTS OVER SMALLER RIVERS, STREAMS AND DRAINS

The use of cylindrical culverts, on smaller watercourses in use by otters, should not be considered other than in exceptional circumstances. As such culverts fill rapidly after rainfall, leading to high water speeds, otters will often be averse to using them. Cylindrical culverts or boxed culverts have to be oversized to allow for the provision of ledges.

Where water levels in the culverts are high, otters will tend to cross over the new road, potentially resulting in mortalities. Where such culverts are necessary, an alternative underpass should be provided. Obstacles to mammal passage, such as weirs and sluice gates, should allow for ledges or steps by which mammals may avoid them. Refer to the *Guidelines for the Crossing of Watercourse during the Construction of National Road Schemes* (National Roads Authority, 2005) for culvert specifications.

LEDGES AT WATER CROSSINGS

Ledges are walkways that allow mammals to cross under a road scheme at water crossings where there is inadequate provision for dry-ground passage at bridges and culverts. Ledges shall be at least 500mm wide, constructed at least 150mm above the 1 in 5 year flood event, and allow at least 600mm headroom. They are usually constructed of solid concrete on one or both sides of a bridge or culvert, but they may also be made of wooden or metal planks, sometimes bolted onto the structure's sides. It may be an option to install prefabricated culverts with integrated ledges.

Whilst a ledge on both sides of a water crossing is usually recommended, only one ledge might be feasible within a particular bridge or culvert. Where this is the case, reference to the badger survey is advised - as it may indicate a preference for the ledge to be on one particular side of the water crossing. There must be adequate access to any ledges provided from the riverbank next to the ledge. Ledges transversing the crossing can also be included to allow mammals from either side of the watercourse to reach and utilise a single ledge incorporated into the bridge or culvert. The ledges and mammal access paths should be linked and landscaped appropriately so that otters, badgers, and other mammals will use them.

UNDERPASSES FOR OTTERS AND BADGERS

Otters are disinclined to use water-filled culverts without dry pathways. Where circumstances do not allow for adequate provision of ledges or larger culverts, an alternative is to provide underpasses (tunnels) next to the watercourse crossing. Such underpasses for otters will be similar to those for badgers. The underpass should be composed of 600mm diameter concrete pipes. See *Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes*, National Roads Authority, 2005. Ramps may be required to ensure accessibility to the wildlife underpass. These tunnels should be kept as short and as straight as possible and, where feasible, daylight should be visible through the underpass. Drainage should be adequate to prevent water-logging at the entrances and within the underpass. The tunnels should be constructed as close to the watercourse as possible, with animals guided to them by walls (or fencing) and appropriate landscaping.

cont... WATER CROSSINGS

MAMMAL FENCING

Otters will often cross roads some distance from watercourses. Mammal-resistant fencing should be incorporated on either side of all watercourses at which otter presence is known and should stretch to at least 25m and preferably to 50m or more either side of the crossing. Often, badger-resistant fencing will also have been recommended at locations along the route, including, possibly, at water crossings; such fencing is more than adequate for otters. Those constructing mammal resistant fencing should adhere to the relevant specifications set out in Figure 1 Mammal Fencing.

MAINTENANCE OF RIPARIAN COVER AND LANDSCAPING

Construction works at water crossings will impact on the existing riparian vegetation cover. Where practicable, such cover, using the same native species, should be restored as soon as possible after construction so as to limit short-term and longer-term impacts on the use of watercourses by faunal species. Riparian habitats can often be improved by additional planting along the affected watercourses. The aim of landscaping should be to ensure, in so far as is possible, maintenance of a vegetated wildlife corridor along all watercourses affected by any scheme (refer *A Guide to Landscape Treatments for National Road Schemes in Ireland*, National Roads Authority, 2006). Access to ledges and underpasses must be provided by appropriate levelling and landscaping, thereby ensuring free movement by mammals to the underpass entrances or mammal walkways. Care must be taken to ensure that planting does not obscure entrances to wildlife underpasses or limit access to wildlife ledges provided at bridges and culverts - either in the short-term or the long-term.

Access to ledges and underpasses must be provided by appropriate levelling and landscaping, thereby ensuring free movement by mammals to the underpass entrances or mammal walkways.

POST-CONSTRUCTION MONITORING AND MITIGATION

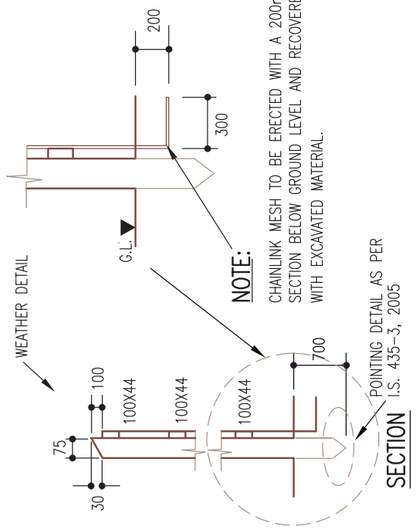
Depending on the type of contract, post-construction monitoring requirements should be stipulated in the Employer's Requirements or Maintenance requirements for local authorities. Maintenance of otter underpasses and means of access by otters to ledges at bridges and culverts is necessary at regular intervals. Obstacles, such as accumulated debris and branches, or, excessive growth of woody vegetation, that could impede passage of otters and other mammals, may need to be removed from underpass tunnels, culverts, etc.

Upon completion of the road construction, quarterly monitoring should be carried out over a period of at least one year to determine the success of the measures employed in an effort to ensure protection of otter populations. The principal measure of success is a continued use of the affected watercourses by otters at water crossings known to be used by otters.

Any deficiencies in the measures should be reported to the relevant authority and corrected where possible.

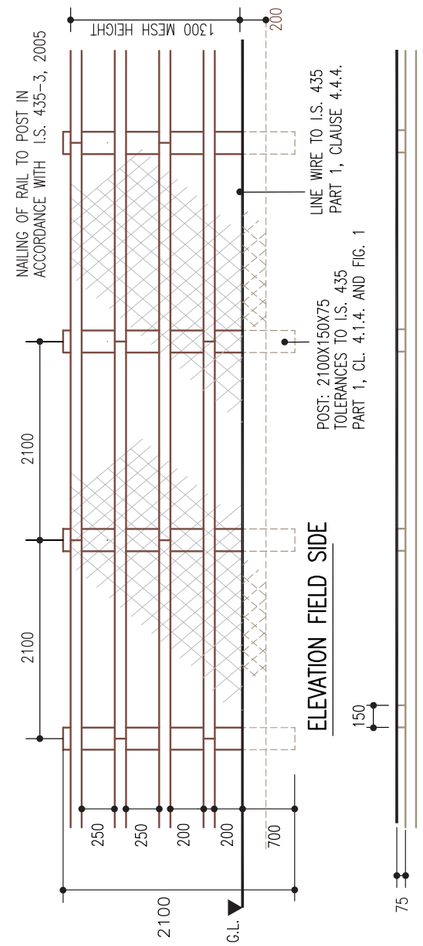
Where necessary otter mitigation measures may have also been provided outside of the landtake of the scheme. Monitoring to assess the effectiveness of such measures can only be undertaken with the permission of the landowner.

FIGURE 1: SPECIFICATION FOR MAMMAL RESISTANT FENCING



NOTES A:

1. FENCES SHALL BE CONSTRUCTED AND ERECTED IN ACCORDANCE WITH IS. 435: 2005 EXCEPT WHERE OTHERWISE SHOWN.
2. ANY LENGTH OF FENCING (INCLUDING BRANCHES AND SPURS) SHALL START WITH A POST AND END WITH A POST. AN ADDITIONAL POST SHALL BE PROVIDED AT FENCE JUNCTIONS AND AT FENCE CORNERS.
3. POST HOLES FALLING IN ROCK SHALL BE EXCAVATED TO THE DEPTH SHOWN ON THIS DRAWING OR, WITH THE ENGINEER'S APPROVAL, TO A DEPTH OF 500mm, AND SHALL BE BACKFILLED WITH MIX ST2 CONCRETE. WHERE A REDUCED DEPTH OF HOLE IS ACCEPTED BY THE ENGINEER, THE TOP OF THE POST SHALL BE SUITABLY CUT AND TREATED IN ACCORDANCE WITH THE RECOMMENDATIONS OF IS.435: 2005.
4. FENCE POST AND RAIL SHALL BE TREATED WITH PRESERVATIVE IN ACCORDANCE WITH THE REQUIREMENTS OF SERIES 300 OF THE SPECIFICATIONS FOR ROAD WORKS AND APPENDIX B OF IS.435-1: 2005.
5. CONCRETE FOUNDATIONS TO POSTS SHALL BE PROVIDED WHERE STATED IN APPENDIX 1/3 OR AS DIRECTED BY THE ENGINEER.



NOTES B:

CHAINLINK MESH SHALL BE 1800mm WIDE, 60mm MESH MADE OF 2.25/3.15mm DIAM. PLASTIC COATED GALVANISED MILD MESH STEEL WIRE TO IS EN 10223-6.

FIXING.

FIXING IN ACCORDANCE WITH I.S. 435-3:2005, NOTES 13 AND 14 AND SECTION 4.4 OF I.S. 435-1, 2005

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CONTACT

National Parks & Wildlife Service
Department of the Environment, Heritage and Local Government
7 Ely Place, Dublin 2
Tel: 01 8882000
Email: natureconservation@environ.ie
Web: www.npws.ie

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NOTES

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B2 Badgers

GUIDELINES FOR THE TREATMENT OF BADGERS PRIOR TO THE CONSTRUCTION OF NATIONAL ROAD SCHEMES

NRA National Roads Authority
An tÚdarás um Bóithre Náisiúnta

NRA National Roads Authority
An tÚdarás um Bóithre Náisiúnta

GUIDELINES FOR THE TREATMENT OF BADGERS PRIOR TO THE CONSTRUCTION OF NATIONAL ROAD SCHEMES

ENVIRONMENTAL SERIES ON CONSTRUCTION IMPACTS

National Roads Authority
St Martin's House, Waterloo Road, Dublin 4
Tel: **01 6602511**
Web: **www.nra.ie**

This document was prepared by: Dr. Chris Smal, Ecological Solutions, 64 The Grove, Greystones, Co. Wicklow, and NATURA Environmental Consultants, Enterprise Centre, Murrough, Wicklow.

Photographs and figures in text provided by Dr. Chris Smal and Richard Mills.
Underpass and badger-resistant fencing drawings provided by Halcrow on behalf of the National Roads Authority.

GUIDELINES FOR THE TREATMENT OF BADGERS PRIOR TO THE CONSTRUCTION OF NATIONAL ROAD SCHEMES

INDEX

INTRODUCTION

The badger is one of the larger wild mammals in Ireland and is relatively common and widespread throughout most of the country. Badgers are omnivorous, feeding on insects, small mammals, grains and wild fruits - but the main component of their diet is earthworms. Consequently, their density is often higher in landscapes of agricultural pasturelands and lower in areas where habitats provide a poorer food supply, such as bogs, moors and upland areas.

Badgers live in social groups, usually comprised of between two and six adults and their young. Each group defends a territory, which varies in size between 25 and 200ha (with mean territory size of ***c***. 80ha). The average density of badgers in the country is one social group per 2 km^2 but in many lowland areas is often as much as one or more social groups per km^2.

Badgers create burrows (known as setts); larger setts may possess very extensive tunnel systems with many entrances and underground chambers. There may be a number of setts within a group's territory, varying in size, complexity and use. Usually, there is just one principal sett (the 'main' sett), which is generally used for breeding and is inhabited by badgers throughout the year. It is usually located centrally within the badger group territory. Setts closer to the boundary of a territory are usually referred to as 'outlier' setts. Other types of sett include annexe, subsidiary and minor setts, depending on their use and importance to the badger group. Setts vary in size from those with one entrance to complexes stretching over 100m and with 40 or more entrances.

The most frequent location of badger setts in the Irish countryside is within or close to hedgerows and treelines, as these provide cover and safety from disturbance from agricultural and other activities. Setts are also frequently located in deciduous woodlands and areas of scrub, and they do occur in urban areas as well as in the open countryside.

Setts are used by generations of badgers and some setts may be of considerable antiquity. Cubs are born (litters consist of two to four cubs) towards the end of January and through February, emerging above ground in April or May.

Badger sett with several entrances located in a woodland.

Badgers live in social groups, usually comprised of between two and six adults and their young.

IMPACT OF ROAD SCHEMES

New road infrastructure may directly or indirectly impact on badgers. Construction may result in death or injury to badgers within setts, as well as the destruction of setts, loss of foraging habitat or dissection of their foraging areas. Construction works close to breeding setts can cause serious disturbance to badgers and mortality of cubs.

Where loss of habitat is likely to be greater than 25%, the impact may be considered as significant on the affected social group. Badgers may be killed or injured by road traffic as they attempt to access their feeding areas. This can significantly affect the viability of badger groups in an area. They may also pose a road safety issue for motorists as badgers attempt to cross roads to and from foraging areas.

Badgers are commonly found in woodland areas.
© George McCarthy/naturepl.com

Where loss of habitat is likely to be greater than 25%, the impact may be considered as significant on the affected social group.

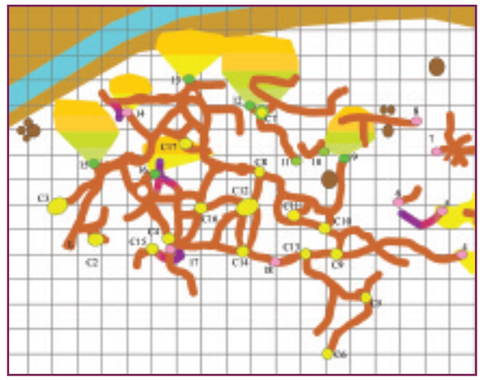
LEGISLATION FOR THE PROTECTION OF BADGERS

Badgers and their setts are protected under the provisions of the Wildlife Act, 1976, and the Wildlife Amendment Act, 2000. It is an offence to intentionally kill or injure a protected species or to wilfully interfere with or destroy the breeding site or resting place of a protected wild animal. It is standard best practice to ensure that mitigation measures are taken to limit impacts on badgers and badger populations and to contribute to safety by reducing collisions between badgers and vehicles. On road schemes, such measures might include removal of badgers from affected setts, provision of badger-resistant fencing and wildlife underpasses (that allow badgers access to their foraging areas). Where significant badger setts have to be removed, alternative artificial setts may need to be created.

The removal of badgers from affected setts and subsequent destruction of these setts must be conducted under licence by experienced badger experts or other suitably qualified personnel. The National Parks and Wildlife Service (NPWS) of the Department of the Environment, Heritage and Local Government grant licences to the experts undertaking the badger operations and not to the developer or contractor. An application for a wildlife licence should be submitted to the NPWS with the relevant ecological information from the detailed badger survey. At least three weeks is normally required to process a licence application, but early discussions with NPWS can expedite the procedure.

Conditions are usually attached to each wildlife licence granted in respect of badgers. It is normal practice to impose seasonal constraints e.g. that breeding setts are not interfered with or disturbed during the badger breeding season (December to June inclusive).

No active sett should be interfered with or disturbed during the breeding season as any sett category may contain cubs. Closure of setts during the breeding season would require monitoring to demonstrate no sett activity.



Sett excavation revealed the underground tunnel system of a sizeable main sett located next to a stream. The sett had 18 entrances, 17 chambers, and was 24m across. Total tunnel length approximately 132m.

It is an offence to intentionally kill or injure a protected species or to wilfully interfere with or destroy the breeding site or resting place of a protected wild animal.

PRE-CONSTRUCTION BADGER SURVEYS

All significant setts and badger activity as well as mitigation measures will already be reported within the Environmental Impact Statement (EIS) for the respective scheme. In general, badger group territories tend to remain remarkably stable over time. However, badgers create new setts regularly and existing setts may change in terms of breeding status or level of use by badgers. Therefore, in order to ensure that there are no significant changes to the badger territory's identified in the EIS and the mitigation measures specified, pre-construction survey should be undertaken prior to the commencement of any works. The priority of any badger pre-construction surveys along the proposed route is to ensure that the prescribed mitigation measures in the EIS are adequate to address possible impacts on badgers.

In general, a survey of setts within 50m of the scheme (150m where piling or blasting will be undertaken) is required no more than 10-12 months in advance of construction. This will ensure that there will be sufficient time to comply with all licensing requirements and that the necessary actions are undertaken to protect the badger populations prior to the commencement of construction. The survey should be supplemented by a further inspection of the development area immediately prior to site clearance to ensure that no new setts were established in the intervening period and that setts previously identified continue to be used by badgers. The additional survey information will allow specialists to modify, where appropriate, the extent and location of badger-resistant fencing and wildlife underpasses.

Where 36 months or more has elapsed between obtaining statutory approval of a road scheme and initiation of the construction phase, an appropriate level of resurvey will be required because the baseline data may be altered during this time. This will allow adjustments to be made to the mitigation strategy specified in the EIS, if necessary (e.g. lengths of fencelines and locations of underpasses etc.).

Badger surveys are significantly constrained by vegetational cover and season, and are best conducted from November to April. All areas have to be systematically searched for setts and both sides of hedgerows and boundaries checked. Badger territorial activity is high from mid-January to March and surveys at this time are most efficient in identification of badger paths, latrines and feeding signs.

Large spoil heap with copious discarded bedding at a main sett located in a hedgerow next to a stream.

A single entrance sett in grassland.

EXCLUSION OF BADGERS FROM DEVELOPMENT SITES

Exclusion of badgers should only be considered where a development would unavoidably destroy a badger sett (or any part of its underground tunnel and chamber system), or its immediate surroundings, making it unsuitable for continued occupancy. In some circumstances, it is possible to exclude badgers on a temporary basis and allow them to return when the site works have been completed. Exclusion of badgers from any currently active sett should only be carried out during the period of July to November (inclusive) in order to avoid the badger breeding season. Closure of any active sett during this period (i.e. a potential breeding sett) would result in the exclusion of adult badgers, while, if present, dependent young are likely to remain below ground. Knowledge of alternative setts within the particular social group's territory is required to ensure that excluded badgers are able to relocate to a suitable alternative refuge. The objective is to allow the badgers to remain within their territory, even though a portion of their current territory may be lost as a result of a particular development.

Exclusion of badgers from disused or currently inactive setts, may be entertained during any season. Confirming that a sett is inactive during the breeding season (i.e. as described above, with no possibility of cubs below ground) will usually require a brief period of sett monitoring (e.g. five or more days of checking activity either with sticks or with sand pads on the spoil heaps to identify footprints).

In circumstances where there are difficulties in identifying alternative setts available to the affected badger group, specialist studies (e.g. bait-marking) may have to be undertaken to ascertain the group's territory and to locate alternative setts. Where no alternative setts are available within the territory of the animals, an artificial sett will need to be constructed within the affected group's territory. While individual situations may require different approaches, exclusion will generally follow the steps outlined in the next section.

Exclusion of badgers from disused or currently inactive setts, may be entertained during any season.

Badger paths are normally alongside hedges and treelines, but may cross open fields. Badgers maintain traditional paths and a hedge may have been removed from here in the past.

BADGER EVACUATION PROCEDURES

Prior to any work commencing in the vicinity of a badger sett that will be affected by a road scheme, it must be ensured that badgers are excluded and evacuated from the sett. Badgers will not necessarily make regular use of all of the setts in their territory; some setts may be used only intermittently. Nevertheless, all setts should be considered as resting places under the Wildlife (Amendment) Act, 2000.

The methodology by which a licensed operative evacuates a sett depends largely on the number of sett entrances, the observed activity at the sett, terrain and topography, likelihood of interference by people and livestock, and other considerations; therefore, it should be determined on a case-by-case basis. The activity status of a sett is adjudged by field signs at and around the sett: evidence of paths, rooting, bedding etc. will suggest recent or intermittent use.

The procedures below are usually sufficient to ensure that badgers are not present within a sett prior to its destruction.

Wire mesh around the gate needs to be buried or securely pegged.

Examples of a one-way gate in place over one of several sett entrances at setts being evacuated.

DISUSED AND INACTIVE SETTS

In the instance of disused setts or setts verified as inactive, and to prevent their reoccupation, the entrances may be lightly blocked with vegetation and a light application of soil (soft blocking). The purpose of soft-blocking is to confirm that an apparently inactive sett is not occupied by badgers. If all entrances remain undisturbed for approximately five days, the sett should be destroyed immediately using a mechanical digger, under the supervision of the licensee. Should there be any delay in sett destruction, the soft-blocked entrances should be hard-blocked and the sett destroyed as soon as possible, again under the supervision of the licensee. Hard-blocking is best achieved using buried fencing materials and compacted soil with further fencing materials laid across and firmly fixed to blocked entrances and surrounds.

ACTIVE SETTS

Where field signs or monitoring reveal any suggestion of current or recent badger activity at any of the sett entrances, the sett requires thorough evacuation procedures.

Inactive entrances may be soft and then hard-blocked, as described for inactive setts, but any active entrances should have one-way gates installed (plus proofing around sides of gates as illustrated) to allow badgers to exit but not to return. The gates should be tied open for three days prior to being set to exclude. Sticks should be placed at arm's length within the gated tunnels to establish if badgers remain within the sett.

Gates should be left installed, with regular inspections, over a minimum period of 21 days (including period with gates tied open) before the sett is deemed inactive. Any activity at all will require the procedures to be repeated or additional measures taken. Gates might be interfered with by other mammals or members of the public - hence the importance of regular exclusion monitoring visits. Sett destruction should commence immediately following the 21 day exclusion period, provided that all badgers have been excluded.

Badgers will often attempt to re-enter setts after a period, and if gates are left in place for any long period, they may attempt to dig around them or even create new entrances and tunnels into the sett system.

Where an extensive sett is involved, an alternative method of evacuating badgers is to erect electric fencing around the sett (ensuring all entrances are included) with one-way badger-gates installed within the electric fence at points where the fence crosses badger paths leading to and from the sett. The exclusion should again take place over a minimum period of 21 days before sett destruction; this monitoring period would be contingent upon no badger activity being observed within the fenced area. Fencing may not be practical in many situations due to the topography or the terrain – and can be difficult to install effectively. If no activity is observed, then the sett may be destroyed, under supervision by the licensed wildlife expert.

BADGER SETT DESTRUCTION

The destruction of a successfully evacuated badger sett may only be conducted under the supervision of qualified and experienced personnel under licence from the NPWS. The possibility of badgers remaining within a sett must always be considered; suitable equipment should be available on hand to deal with badgers within the sett or any badgers injured during sett destruction.

Destruction is usually undertaken with a tracked 12-25 ton digger, commencing at **c**. 25m from the outer sett entrances and working towards the centre of the sett, cutting **c**. 0.5m slices in a trench to a depth of 2m. Exposed tunnels may be checked for recent badger activity, with full attention paid to safety requirements in so doing.

The sett should be destroyed from several directions, in the above manner, until only the central core of the sett remains.

Once it is ensured that no badgers remain, the core may then also be destroyed and the entire area back-filled and made safe. Sett excavation should, preferably, be concluded within one working day, as badgers may re-enter exposed tunnels and entrances.

A report detailing evacuation procedures, sett excavation and destruction, and any other relevant issues should be submitted to the NPWS, in fulfilment of usual wildlife licence conditions.

A main sett being destroyed. The complex tunnel system and chambers are revealed along the face.

Once it is ensured that no badgers remain, the core may then also be destroyed and the entire area back-filled and made safe.

ARTIFICIAL SETTS

Where survey indicates that suitable alternative natural setts are not present, a badger expert may recommend the construction of an artificial sett to replace a breeding sett that will be affected by the road scheme.

Artificial setts should be constructed several months in advance of the closure of a breeding sett. In this interval, the affected badgers should be encouraged to utilise the artificial sett by means of attractive food baits (peanuts etc.) and materials from the breeding sett added (such as bedding and spoil). The construction of an effective artificial sett is an exercise best conducted by experienced personnel. The sett should be constructed as close as reasonably possible to the natural main sett, and within the group's territory, but, obviously, away from the route of the road scheme. The constructed tunnel and chamber system should be located in well-drained soils, and be landscaped and planted to ensure cover and lack of disturbance. Correct location of an artificial sett is necessary to ensure its successful occupation by the affected badgers. Suitably designed and well-situated, artificial setts are usually successfully occupied by the badgers being re-located. Translocation of badgers from an affected site to a distant locality is rarely considered feasible or practical.

Artificial setts should be constructed several months in advance of the closure of a breeding sett.

An example of an artificial sett under construction, with pipe tunnels and eight chambers.

BADGER UNDERPASSES

The majority of badger road casualties occur where traditional badger paths cross roads. Where badger pathways cross a proposed new road, where feasible, a badger underpass (as outlined in Figure 1) should be provided at the location of each of these pathways. The underpass is usually a 600mm concrete pipe, but may form part of a watercourse culvert or bridge. Badgers are guided into the underpasses by mesh fencing, which also prevents them entering directly onto the road. The lower part of the fence is buried to prevent badgers digging under the fence.

Where an underpass cannot be provided at the exact location, it should be sited as close as feasible to the existing pathways across the proposed road route, preferably following wildlife corridors, e.g. hedgerows.

There will usually be a requirement to provide more than one underpass - should there be numerous pathways intersected by the proposed road. The number and location of underpasses will need to be assessed on a site-by-site basis. The underpasses should be installed at the earliest possible stage in construction and appropriate permanent badger-resistant fencing erected to encourage the badgers to utilize them. Where feasible, permanent fencing should be erected immediately following underpass construction. In addition to the specifications outlined in Figure 1, the following guidelines should be followed in construction of an underpass:

- The exit and entrance to tunnels should be flush with badger-proof fencing and the invert set at ground level. A concrete surround will provide a solid connection to the uprights of the fence and inhibit any efforts to dig. Drainage should be adequate to prevent waterlogging at the entrances and within the underpass.
- Where stream culverts are being laid, structures greater than 1m in diameter/width should be fitted with a raised mammal ledge along one or both sides (where recommended by the wildlife experts; see *Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes*, National Roads Authority, 2005). The ledge should be elevated above normal flood levels. An alternative approach to the provision of a ledge is a separate pipe culvert (600mm) set above flood level adjacent to the stream culvert. Badger-resistant fencing and landscaping measures will be required to guide animals to the culvert.
- The entrances to the underpass may be planted with appropriate hedgerow planting (e.g. holly, hawthorn and blackthorn) to encourage badger use (see *A Guide to Landscape Treatments for National Road Schemes in Ireland*, National Roads Authority, 2005). Such planting should not obscure the entrances to the underpass.

BADGER-RESISTANT FENCING

The requirements for badger-resistant fencing are specified in Figure 2. Fencing is required to prevent badgers from crossing the road at points other than at the underpasses provided. The fencing must extend to a sufficient distance from underpasses to ensure that badgers will not find easy ways around them. Underpass entrances should be recessed in the fence line, thereby guiding animals to them.

The extent of fencing proposed for a scheme should be determined by the locations at which badgers are likely to encounter it and the frequency with which they would be expected to attempt to cross the road. As badgers are found throughout most of the Irish countryside, it may often be necessary to incorporate badger-resistant fencing along continuous lengths of the road. It is of particular importance to avoid gaps or weak points in fencing at awkward features such as undulating ground or streams as badgers may exploit such weaknesses, thus negating the effectiveness of fencing. Badger-resistant fencing should never be installed asymmetrically; it should be installed in parallel on both sides of the road and care taken to avoid any gaps, which may occur where fencing abuts other features such as hedgerows, footbridges, gates or stiles.

The constructed underpasses and badger-resistant fencing at all sites should be checked to ensure compliance with the specifications.

As badgers are found throughout most of the Irish countryside, it may often be necessary to incorporate badger-resistant fencing along continuous lengths of the road.

GUIDELINES FOR SITE WORKS IN THE VICINITY OF BADGER SETTS

The following provisions should apply to all construction works:

- Badger sett tunnel systems can extend up to *c.* 20m from sett entrances. Therefore, no heavy machinery should be used within 30m of badger setts (unless carried out under licence); lighter machinery (generally wheeled vehicles) should not be used within 20m of a sett entrance; light work, such as digging by hand or scrub clearance should not take place within 10m of sett entrances.
- During the breeding season (December to June inclusive), none of the above works should be undertaken within 50m of active setts nor blasting or pile driving within 150m of active setts.
- Following consultation with the NPWS and badger experts, works closer to active setts may take place during the breeding season provided appropriate mitigation measures are in place, e.g. sett screening, restricted working hours, etc.

In order to comply with these constraints:

- All affected badger setts should be clearly marked and the extent of bounds prohibited for vehicles clearly marked by fencing and signage. Bunting is an option on a temporary basis. Hazard tape is inadequate as it is prone to deterioration and damage by wind or cattle etc.
- All contractors/operators on site should be made fully aware of the procedures pertaining to each sett on site.
- Construction activities within the vicinity of affected setts may commence once these setts have been evacuated and destroyed under licence from the NPWS. Where affected setts do not require destruction, construction works may commence once recommended alternative mitigation measures to address the badger issues have been complied with.
- In almost all circumstances, works close to badger setts may only be conducted under the supervision of a qualified expert under licence from the NPWS.

All contractors/operators on site should be made fully aware of the procedures pertaining to each sett on site.

POST-CONSTRUCTION MONITORING AND MITIGATION

Depending on the type of contract, post-construction monitoring requirements should be stipulated in the Employer requirements or Maintenance requirements for the local authorities.

In order to ensure that mitigating measures are operating effectively, badger-resistant fencing needs to be properly maintained and underpasses checked periodically in the first two years to ensure that they remain clear of debris or have not become waterlogged.

Upon completion of the road construction, quarterly monitoring should be carried out to determine the success of the measures employed. Monitoring should be continued for at least one year after construction work ceases.

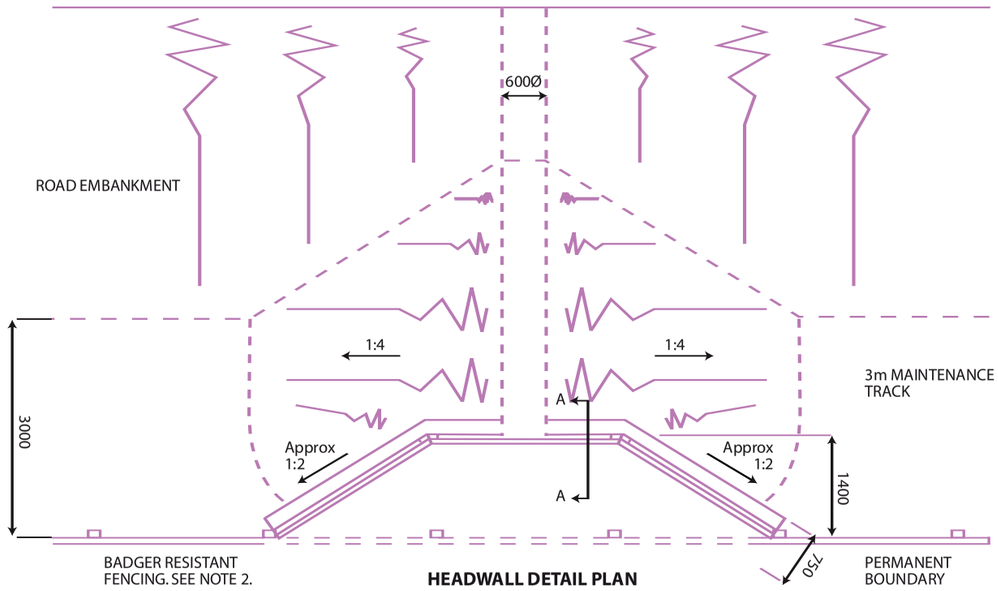
Any deficiencies in the measures should be reported to the relevant authority and corrected where possible. Where the site in question is outside the road land take, such monitoring can only be undertaken with the permission of the landowner.

Badger in open location. © Colin Seddon/naturepl.com

FIGURE 1: SPECIFICATIONS FOR THE CONSTRUCTION OF A BADGER UNDERPASS

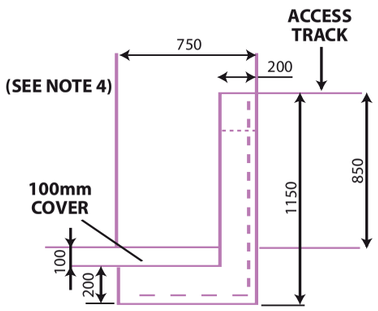
NOTES:

1. ASSUME 600Ø PIPE CROSSES THROUGH THE ROAD EMBANKMENT.
2. SEE FIGURE 2 FOR DETAILED REQUIREMENTS OF FENCING.
3. THIS DRAWING IS AN INDICATIVE (TYPICAL) DETAIL DESIGN/DETAILING OF DRAINAGE, SERVICES AND THE HEADWALL ARE TO BE UNDERTAKEN ON A SCHEME SPECIFIC BASIS.
4. CONCRETE TO HEADWALL TO BE 30N/mm². REINFORCEMENT TO BE A393 MESH (WITH 40 COVER) BENT TO "L" SHAPE AS SHOWN.

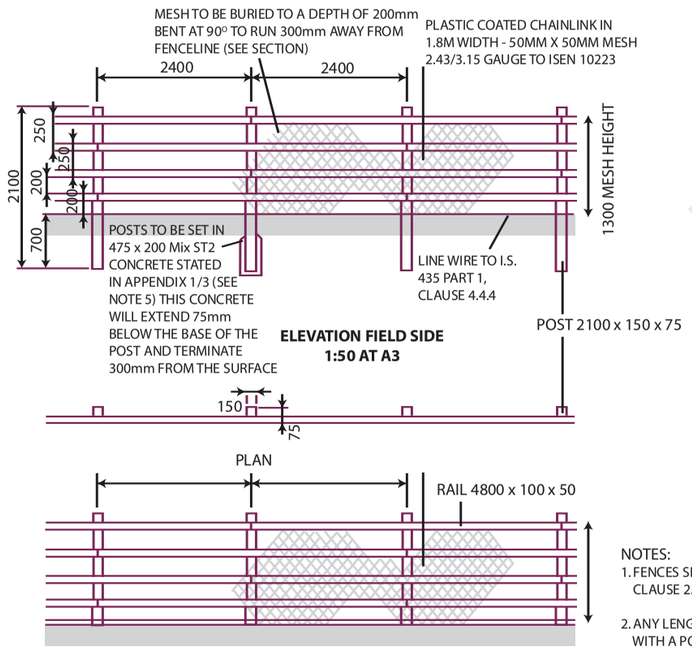


HEADWALL DETAIL PLAN

ELEVATION

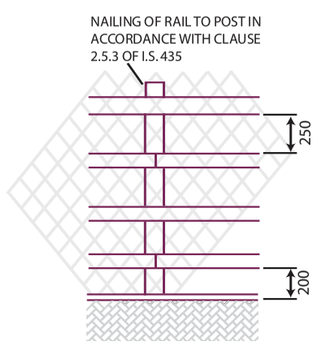


CROSS SECTION A-A
1:20 @A3

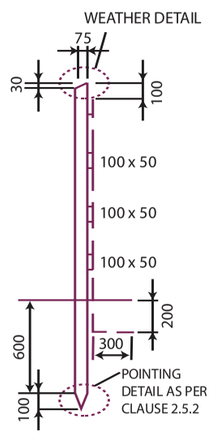


ELEVATION FIELD SIDE
1:50 AT A3

ELEVATION ROAD SIDE
1:50 AT A3



ELEVATION FIELD SIDE
1:25 AT A3



SECTION
1:25 AT A3

FIXING

1. FIX 1 LINE WIRE TO THE FIELD SIDE OF POSTS AS CLOSE TO GROUND LEVEL AS POSSIBLE.
2. SECURE CHAINLINK MESH TO THE FIELD SIDE OF RAILS WITH 4 STAPLES PER LIN. METRE ON THE TOP RAIL AND 1 STAPLE PER LIN. METRE ON THE OTHER RAILS. SECURE TO LINE WIRE WITH 2mm TYING WIRE OR WITH APPROVED GALVANISED HOG-RINGS AT 4 TIES/HOG-RING PER METER 2mm GALV. M.S. TYING WIRE TO COMPLY WITH BS 1722 WIRE. STAPLES SHALL BE GALV. 30mm x 3.75mm ROUND.

NOTES:

1. FENCES SHALL BE CONSTRUCTED IN ACCORDANCE WITH IS 435 AND ERECTED IN ACCORDANCE WITH CLAUSE 2.5 OF IS 435 EXCEPT WHERE OTHERWISE SHOWN.
2. ANY LENGTH OF FENCING (INCLUDING BRANCHES AND SPURS) SHALL START WITH A POST AND END WITH A POST. AN ADDITIONAL POST SHALL BE PROVIDED AT FENCE JUNCTIONS AND AT FENCE CORNERS.
3. POST HOLES FALLING IN ROCK SHALL BE EXCAVATED TO THE DEPTH SHOWN ON THIS DRAWING OR, WITH THE ENGINEER'S APPROVAL, TO A DEPTH OF 500mm AND SHALL BE BACK FILLED WITH MIX ST2 CONCRETE. WHERE A REDUCED DEPTH OF HOLE IS ACCEPTED BY THE ENGINEER, THE TOP OF THE POST SHALL BE SUITABLY CUT AND TREATED IN ACCORDANCE WITH THE RELEVANT CCA OR MANUFACTURER'S RECOMMENDATIONS.
4. FENCE TYPES SHALL BE AS FOLLOWS DEPENDING ON THE REQUIRED PRESERVATION TREATMENT:

   TYPE A COPPER-CHROME-ARSENIC IN ACCORDANCE WITH IS 435 AND IS/EN 599, PARTS 1 AND 2.

   TYPE B CREOSOTE IN ACCORDANCE WITH IS 435.
5. CONCRETE FOUNDATIONS TO POST SHALL BE PROVIDED WHERE STATED IN APPENDIX 1/3 OR DIRECTED BY THE ENGINEER.

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CONTACT

National Parks & Wildlife Service
Department of the Environment, Heritage and Local Government
7 Ely Place, Dublin 2
Tel: 01 6472300
Email: natureconservation@environ.ie
Web: www.npws.ie/

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NOTES

Appendix C

Dry Heath Creation

C1 Bibliography

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C2 Corrib Onshore Pipeline Example

200303 CORRIB PHOTOS FOR AEBHIN CAWLEY

A. AREA OF HEAVILY ERODED BLANKET BOG (tunnel launch compound)

1.Bespoke bucket used to lift surface vegetation turves (3m x 1m x 0.3 deep)

Sequence

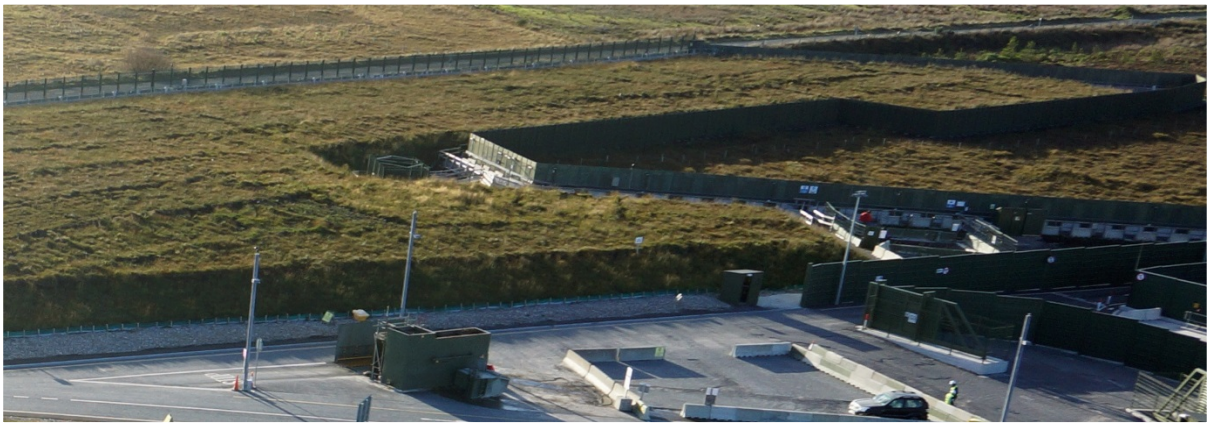
2a. lifting turve

2b. Transfer bucket + turve to back of low impact truck

2c. Transport to peat storage area

2d. Lift bucket + turve off back of truck and place on turve storage area

3a Peat storage area (aerial)



3.b One of the peat storage areas - with turves growing on top and on sloping sides (after 1 year)

4. Reinstatement

Effectively reverse the process, lifting turves from the storage areas with turving bucket but used large multiforked bespoke 'bucket' to lift them from back of truck and placed carefully into position. Three turves placed together to form matrix of 3 x 3m and the interstices filled with stored peat up to the level of the replaced turves.

4a to show forked bucket

4b placement

4.c The end result. Bare peat interstices were planted with *Eriophorum angustifolium* plantlets (64,000 in total) and seeded with locally collected ericaceous seed.

4.d Working edge visible, also newly created wetland (in peat) - Sruwaddacon Bay in the background.

B. PIPELINE WAYLEAVE TURVING IN ± INTACT BLANKET BOG

i. Used bespoke bucket: 2m x 1m x 0.5 deep

ii. Then transferred from the 'lifting' machine's bucket to the machine placing turves on bogmats in the adjacent storage area – required excellent driver coordination and care.

iii. Turve storage on bogmats (on RHS of sheet piled haul road and trench section on left)

iv. Turves after lifting

v. Exposed edges firmly wrapped in silt fencing to prevent drying and erosion while in storage

C. LANDFALL VALVE INSTALLATION LOCATION

1. Use of Geocoir with vegetation establishing on Landfall Valve Instiallion

2. Use of Geojute with vegetation establishing on Landfall Valve Instiallion side slopes

C3 Geocoir and Geojute Specification

Geo-Coastal Engineering Ltd

Geocoir & Geojute

Description

Manufactured from 100% high quality coir or jute fibres, **Goecoir** and **Geojute** erosion control netting is produced from spun coir or jute twine.

Geocoir is available in two grades, 750 gram and 900 gram . Both the grades provide a strong and durable short to mid term protection with an anticipated de-composition longevity of over 5 years.

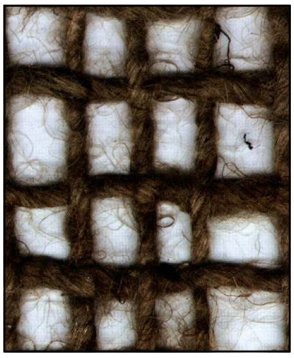
Geojute

Manufactured from unbleached jute fibre, Geojute is a lightweight yet effective net for use in prevention of erosion. It will typically degrade in one season and is used where short term protection is required.

Geojute holds up to 5 times it's own weight in water and when used in conjunction with hydroseeding can be invaluable for the establishing of new grass seedlings.

Uses

- Newly cut slopes
- Top soiling on slopes
- Landfill cappings
- Watercourse lining
- Soil reinforcement
- Sediment entrapment
- Sand dune stabilisation



3D Coirmat

Description

Manufactured from bristle coir fibre. 3D Coir mat is produced with a Geocoir net base with looped coir fibre upper matrix and is available in roll size 2m x 50m with a weight of 1.2kg/m^2.

The rough upper matrix prevents erosion and slows water runoff, maxi-mising sediment encapsulation. The 20mm upper layer will also retain soil on slopes of up to 25° where little or no soil is present and where a totally biodegradable entrapment and erosion solution is required.

Uses

- Newly cut slopes
- Top soiling on slopes
- Landfill cappings
- Watercourse lining
- Soil reinforcement
- Sediment entrapment
- Ground abrasion protection.

Specification

GEOCOIR	
For use as	**Properties**
River bank/stream bed erosion protection	Long biodegradable period of up 5 years
Sand dune stabilisation	High tensile strength
Some soil erosion control	Drapable
Rockfall screening	Easy to install
Soil abrasion protection i.e. Walkways, and temporary ground protection	

Function	*Name*	*Technical Details*		
Provides soil protection and moderate plant growth opportunities	Geocoir 400	Manufactured from 100% bristle coir fibre	Area Width Length Weight Dia. Weight	100m² 2m 50m 40kg Compressed Folded roll 400gm/m²
Provides soil protection and moderate plant growth opportunities	Geocoir 700	Manufactured from 100% bristle coir fibre Warp threads approx. 110/m Weft threads approx. 70/m	Area Width Length Weight Dia. Weight	50m² 2m 25m 28kg 0.4m 700gm/m²
Provides soil protection and moderate plant growth opportunities	Geocoir 820	Manufactured from 100% bristle coir fibre Warp threads approx. 110/m Weft threads approx. 70/m	Area Width Length Weight Dia. Weight	40m² 2m 20m 30kg 0.4m 750gm/m²
Excellent soil protection, but poorer plant growth potential	Geocoir 900	Manufactured from 100% bristle coir fibre Warp threads approx. 130m Weft threads approx. 70/m	Area Width Length Weight Dia. Weight	40m² 2m 20m 36kg 0.4m 900gm/m²

Function	*Name*	*Technical Details*		
Erosion control and improved plant establishment environment with durability of 1-2 years. Use with handseeding or hydroseeding.	Geojute® 250	Thickness approx. 4mm Open percentage of area, approx. 60-65% Warp threads approx. 64 per m Weft threads approx. 46 per m	Area Width Length Weight Dia. Weight	83.67m² 1.22m 68.58m 20kg (+/-0.5kg) 0.3m 500gm/m²
Erosion control and improved plant establishment environment with durability of 1-2 years. Use with handseeding or hydroseeding.	Geojute® 500	Thickness approx. 5mm Open percentage of area, approx. 60% Warp threads approx. 64 per m Weft threads approx. 46 per m	Area Width Length Weight Dia. Weight	83.67m² 1.22m 68.58m 41.84kg (+/-0.5kg) 0.4m 500gm/m²

C4 Updated Receptor and Donor Sites

Figure 1

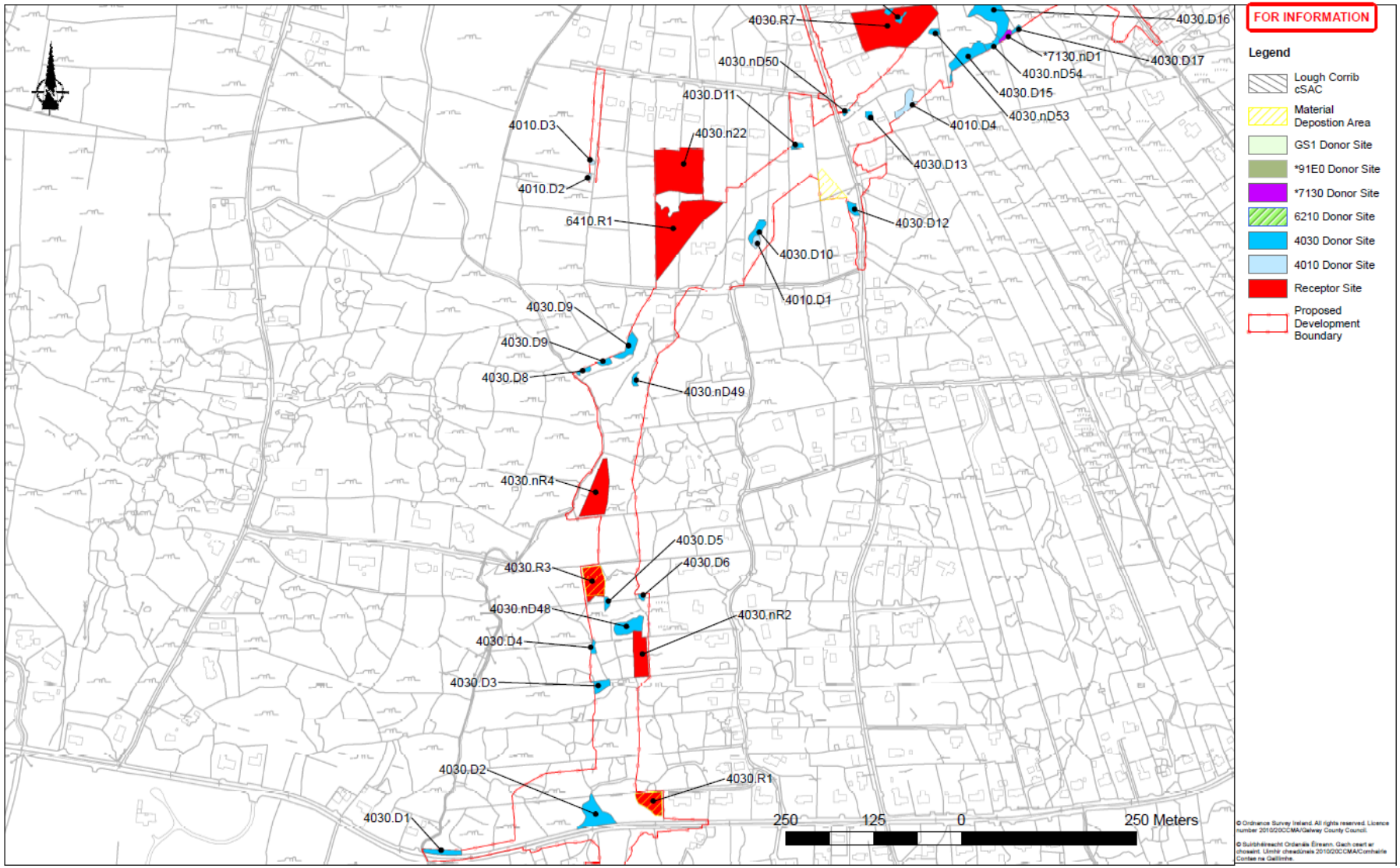

FOR INFORMATION
Legend
Lough Corrib cSAC
Material Depostion Area
GS1 Donor Site
*91E0 Donor Site
*7130 Donor Site
6210 Donor Site
4030 Donor Site
4010 Donor Site
Receptor Site
Proposed Development Boundary
4030.R7
4030.D16
4030.nD50
*7130.nD1
4030.D17
4030.nD54
4030.D11
4030.D15
4030.nD53
4010.D3
4030.n22
4010.D4
4030.D13
4010.D2
6410.R1
4030.D12
4030.D10
4010.D1
4030.D9
4030.D9
4030.D8
4030.nD49
4030.nR4
4030.D5
4030.R3
4030.D6
4030.nD48
4030.nR2
4030.D4
4030.D3
4030.D2
4030.R1
4030.D1
250
125
0
250 Meters

Figure 2

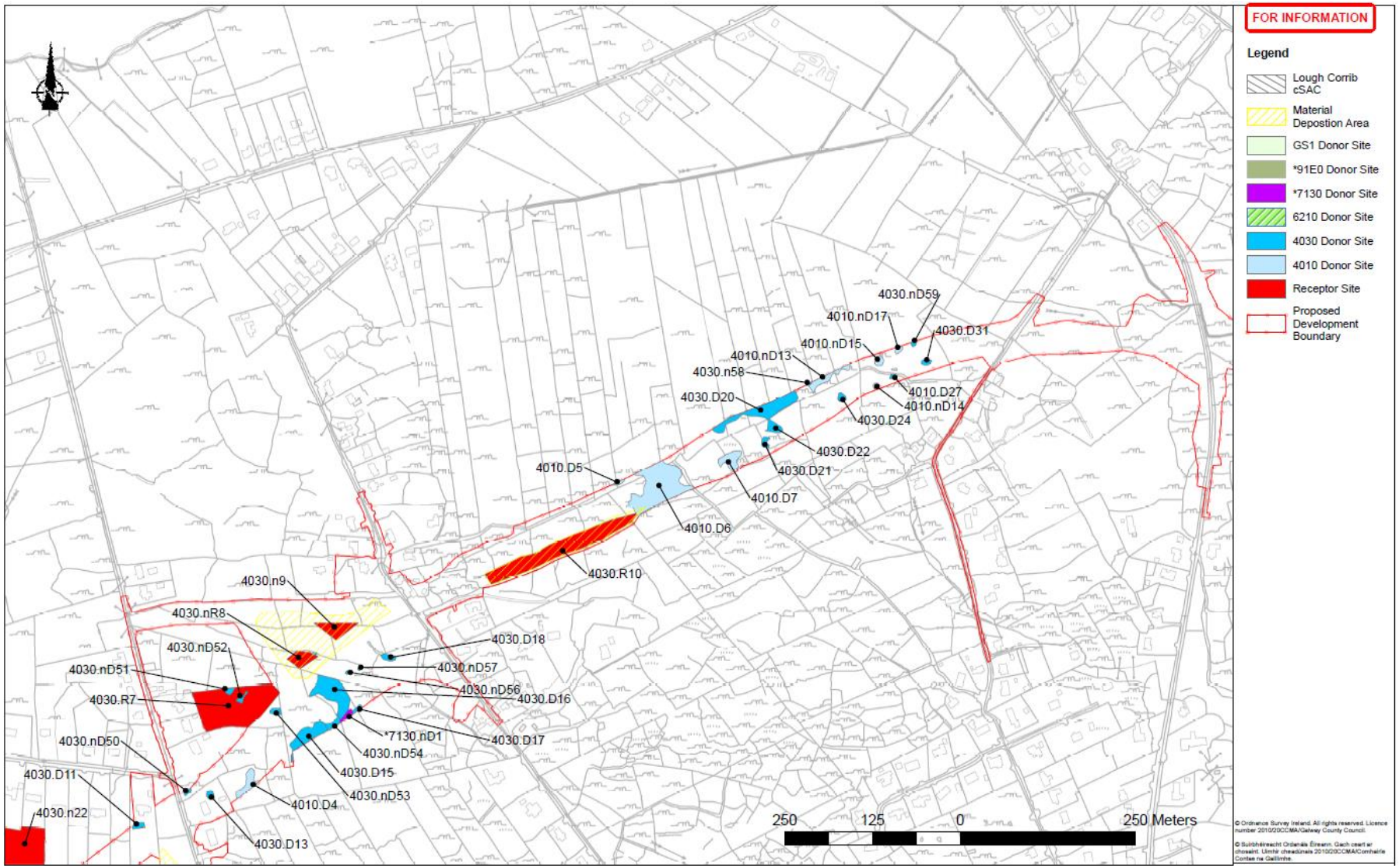
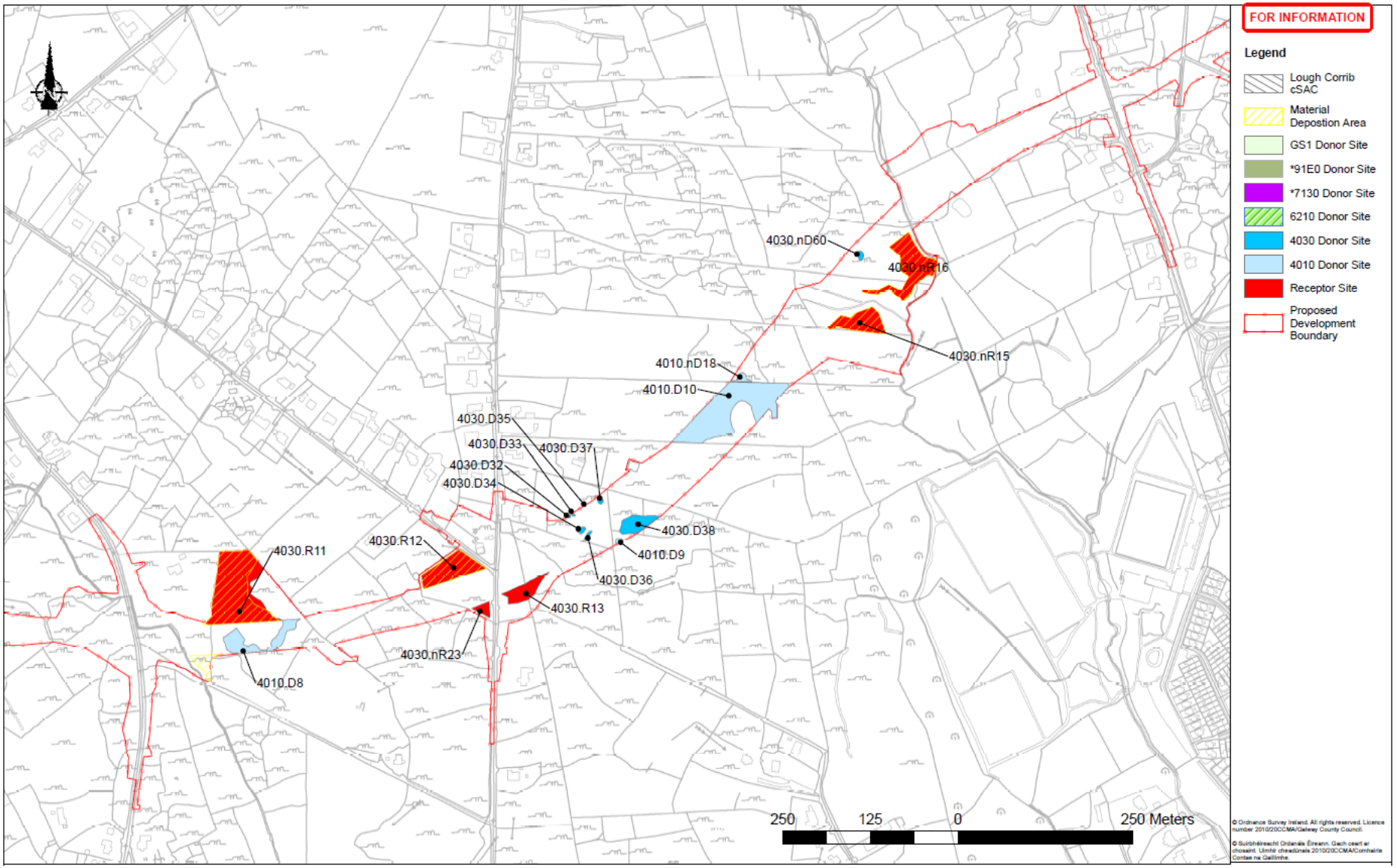

FOR INFORMATION
Legend
Lough Corrib cSAC
Material Depostion Area
GS1 Donor Site
*91E0 Donor Site
*7130 Donor Site
6210 Donor Site
4030 Donor Site
4010 Donor Site
Receptor Site
Proposed Development Boundary
4030.nD59
4010.nD17
4030.D31
4010.nD15
4010.nD13
4030.n58
4030.D20
4010.D27
4010.nD14
4030.D24
4030.D22
4030.D21
4010.D5
4010.D7
4010.D6
4030.R10
4030.n9
4030.nR8
4030.nD52
4030.D18
4030.nD51
4030.nD57
4030.nD56
4030.R7
4030.D16
*7130.nD1
4030.D17
4030.nD50
4030.nD54
4030.D11
4030.D15
4030.nD53
4010.D4
4030.n22
4030.D13
250
125
0
250 Meters

Figure 3


FOR INFORMATION
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Lough Corrib cSAC
Material Depostion Area
GS1 Donor Site
*91E0 Donor Site
*7130 Donor Site
6210 Donor Site
4030 Donor Site
4010 Donor Site
Receptor Site
Proposed Development Boundary
4030.nD60
4030.nR16
4030.nR15
4010.nD18
4010.D10
4030.D35
4030.D33
4030.D37
4030.D32
4030.D34
4030.D38
4010.D9
4030.D36
4030.R12
4030.R11
4030.R13
4030.nR23
4010.D8
250
125
0
250 Meters

Figure 4

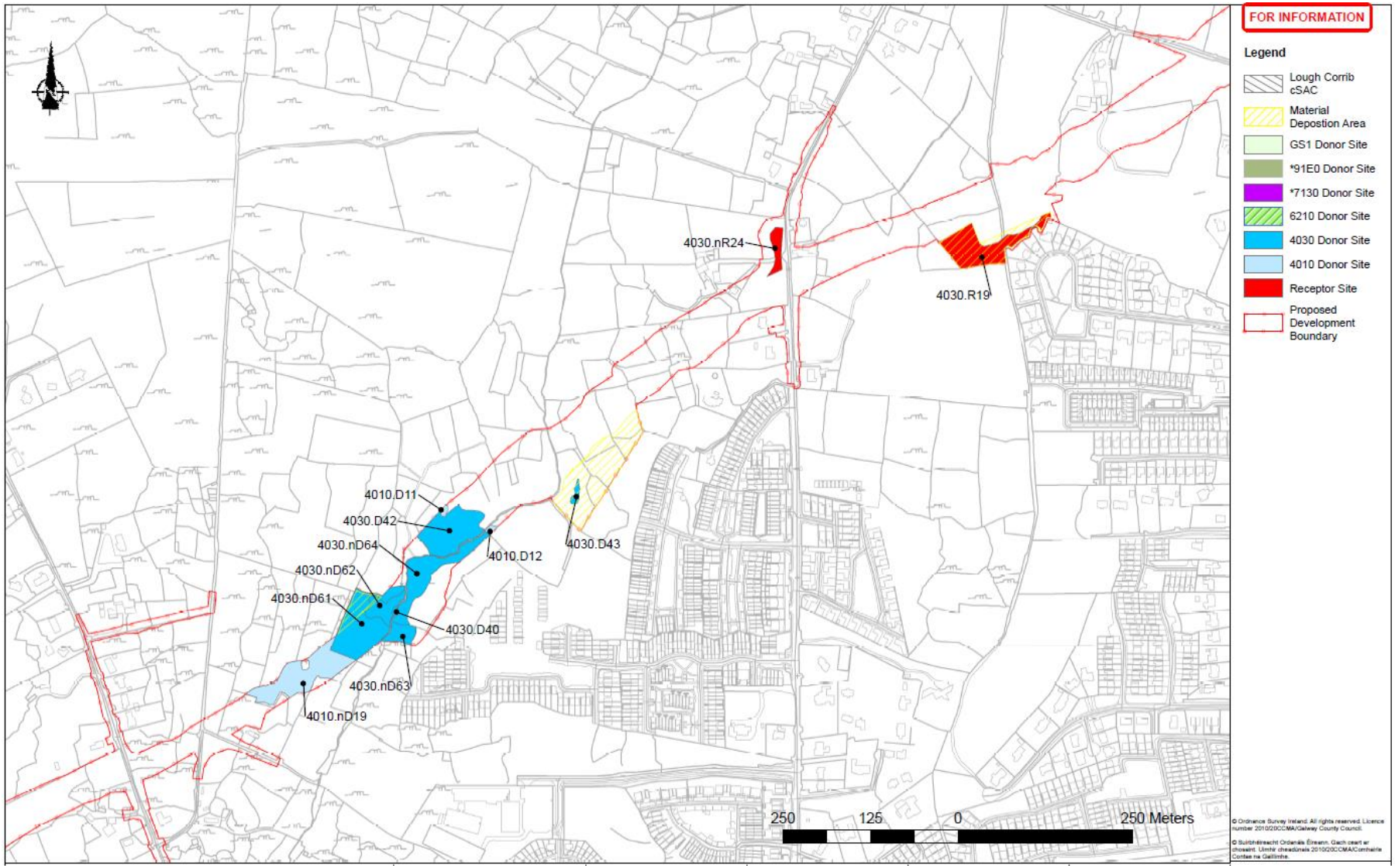

FOR INFORMATION
Legend
Lough Corrib cSAC
Material Depostion Area
GS1 Donor Site
*91E0 Donor Site
*7130 Donor Site
6210 Donor Site
4030 Donor Site
4010 Donor Site
Receptor Site
Proposed Development Boundary
4030.nR24
4030.R19
4010.D11
4030.D42
4030.nD64
4030.nD62
4030.nD61
4010.D12
4030.D43
4030.D40
4030.nD63
4010.nD19
250
125
0
250 Meters

Figure 5

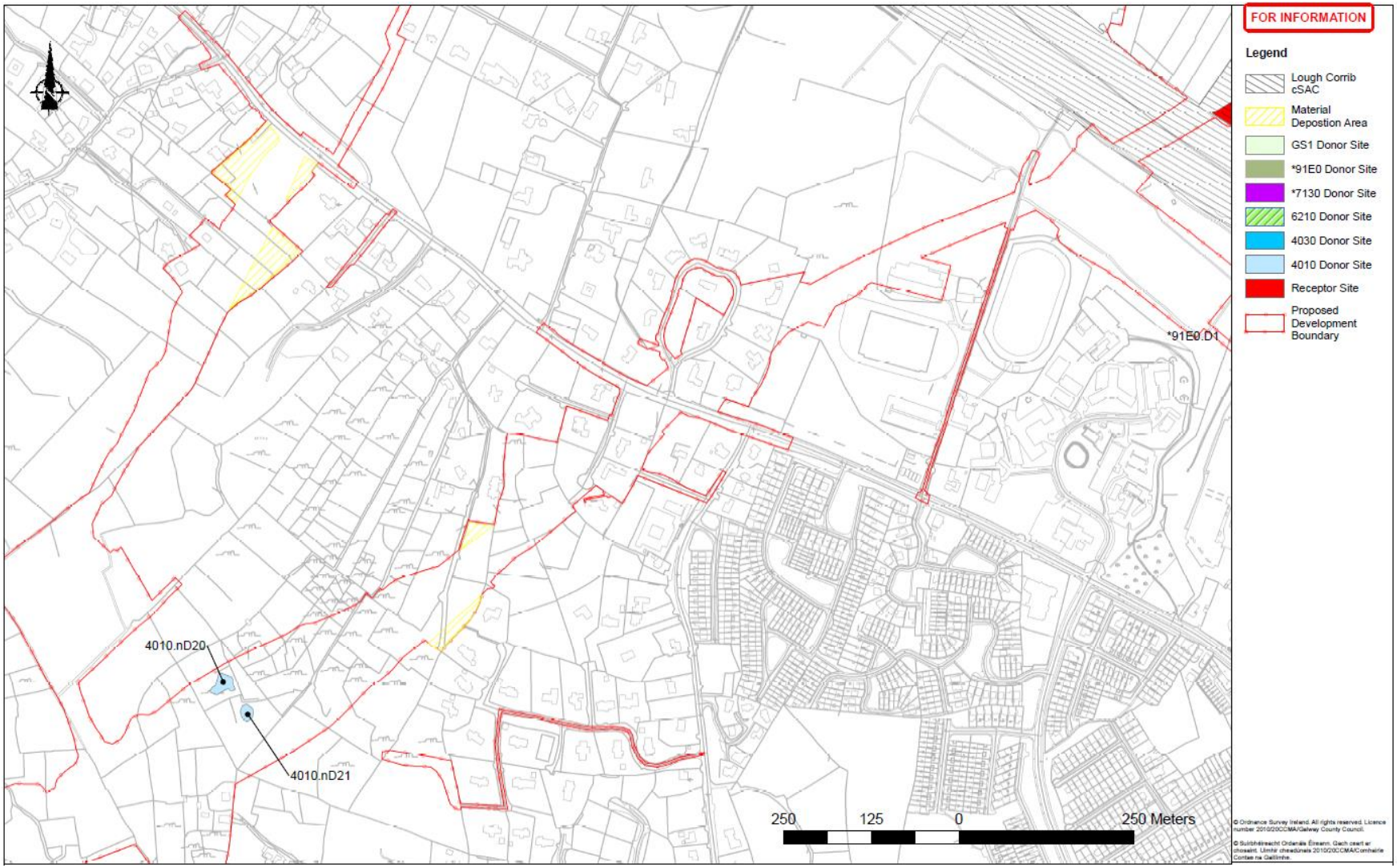

FOR INFORMATION
Legend
Lough Corrib cSAC
Material Depostion Area
GS1 Donor Site
*91E0 Donor Site
*7130 Donor Site
6210 Donor Site
4030 Donor Site
4010 Donor Site
Receptor Site
Proposed Development Boundary
*91E0.D1
4010.nD20
4010.nD21
250
125
0
250 Meters

Figure 6


FOR INFORMATION
Legend
Lough Corrib cSAC
Material Depostion Area
GS1 Donor Site
*91E0 Donor Site
*7130 Donor Site
6210 Donor Site
4030 Donor Site
4010 Donor Site
Receptor Site
Proposed Development Boundary
*91E0.nD4
GS1.D3
*91E0.R1
GS1.D2
6210.R2
GS1.D1
6210.R1
250
125
0
250 Meters

Figure 7

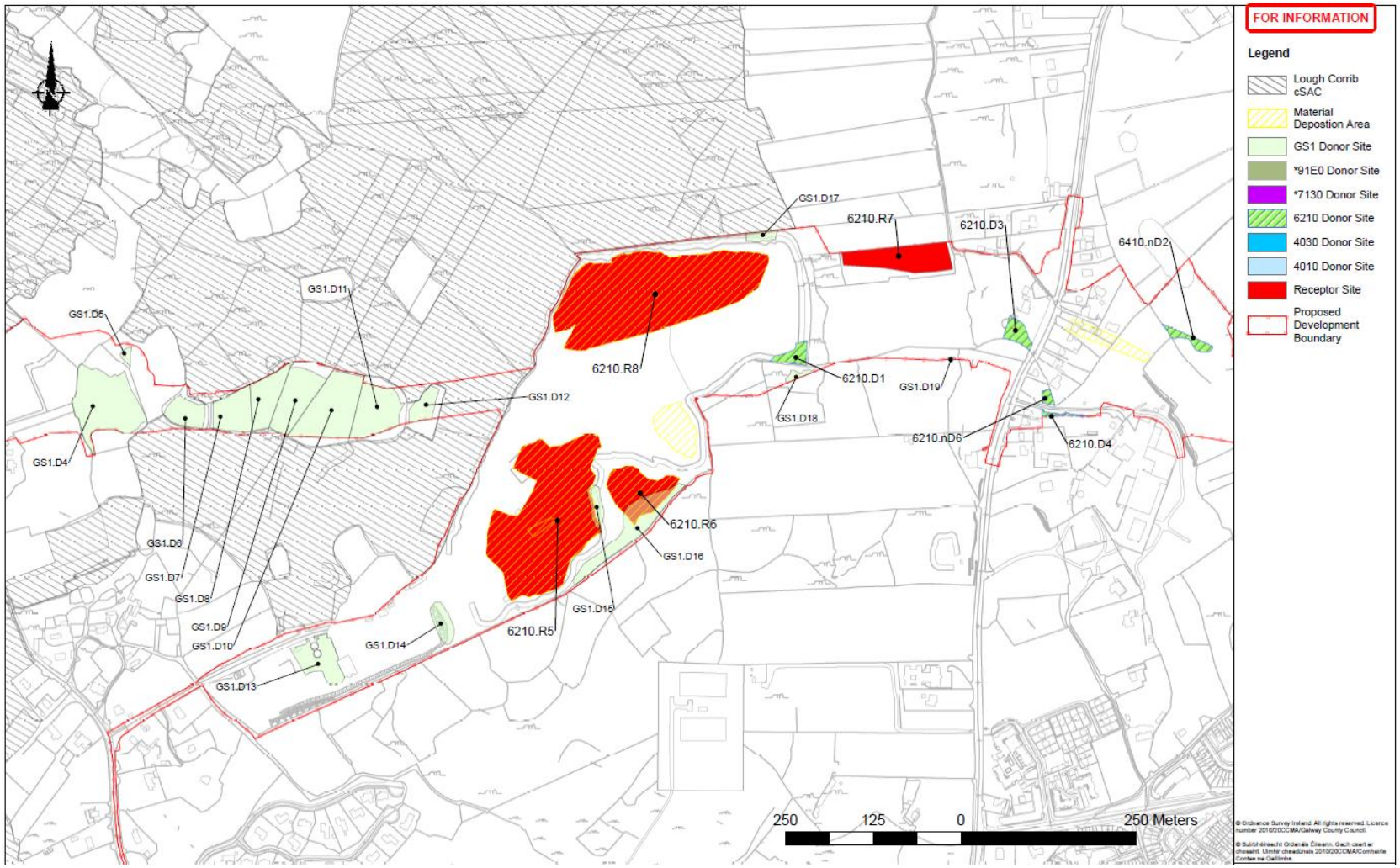

FOR INFORMATION
Legend
Lough Corrib cSAC
Material Depostion Area
GS1 Donor Site
*91E0 Donor Site
*7130 Donor Site
6210 Donor Site
4030 Donor Site
4010 Donor Site
Receptor Site
Proposed Development Boundary
GS1.D17
6210.R7
6210.D3
6410.nD2
GS1.D11
GS1.D5
6210.R8
6210.D1
GS1.D19
GS1.D12
GS1.D18
6210.nD6
6210.D4
GS1.D4
6210.R6
GS1.D6
GS1.D16
GS1.D7
GS1.D8
GS1.D15
GS1.D9
GS1.D10
6210.R5
GS1.D14
GS1.D13
250
125
0
250 Meters

Figure 8

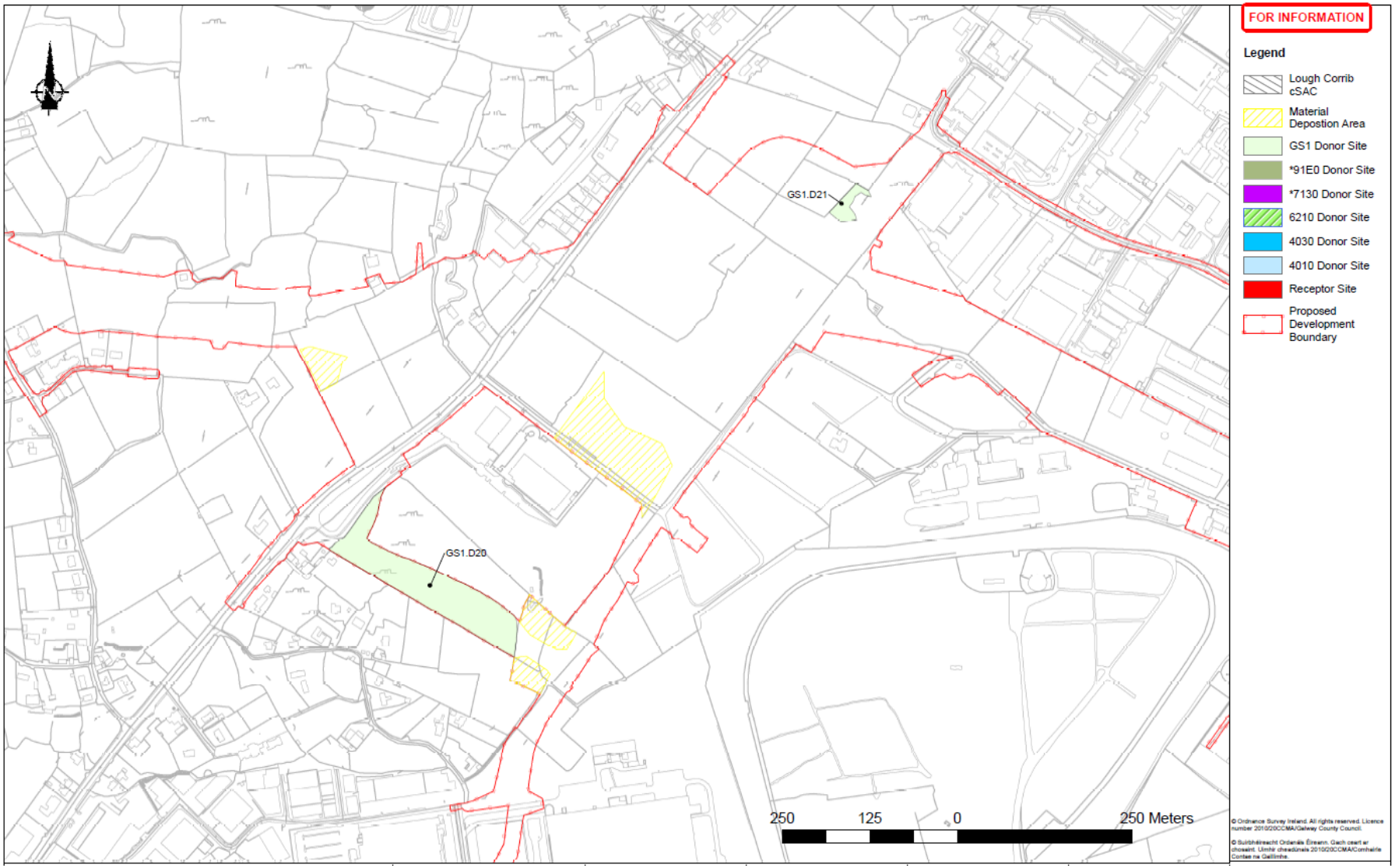
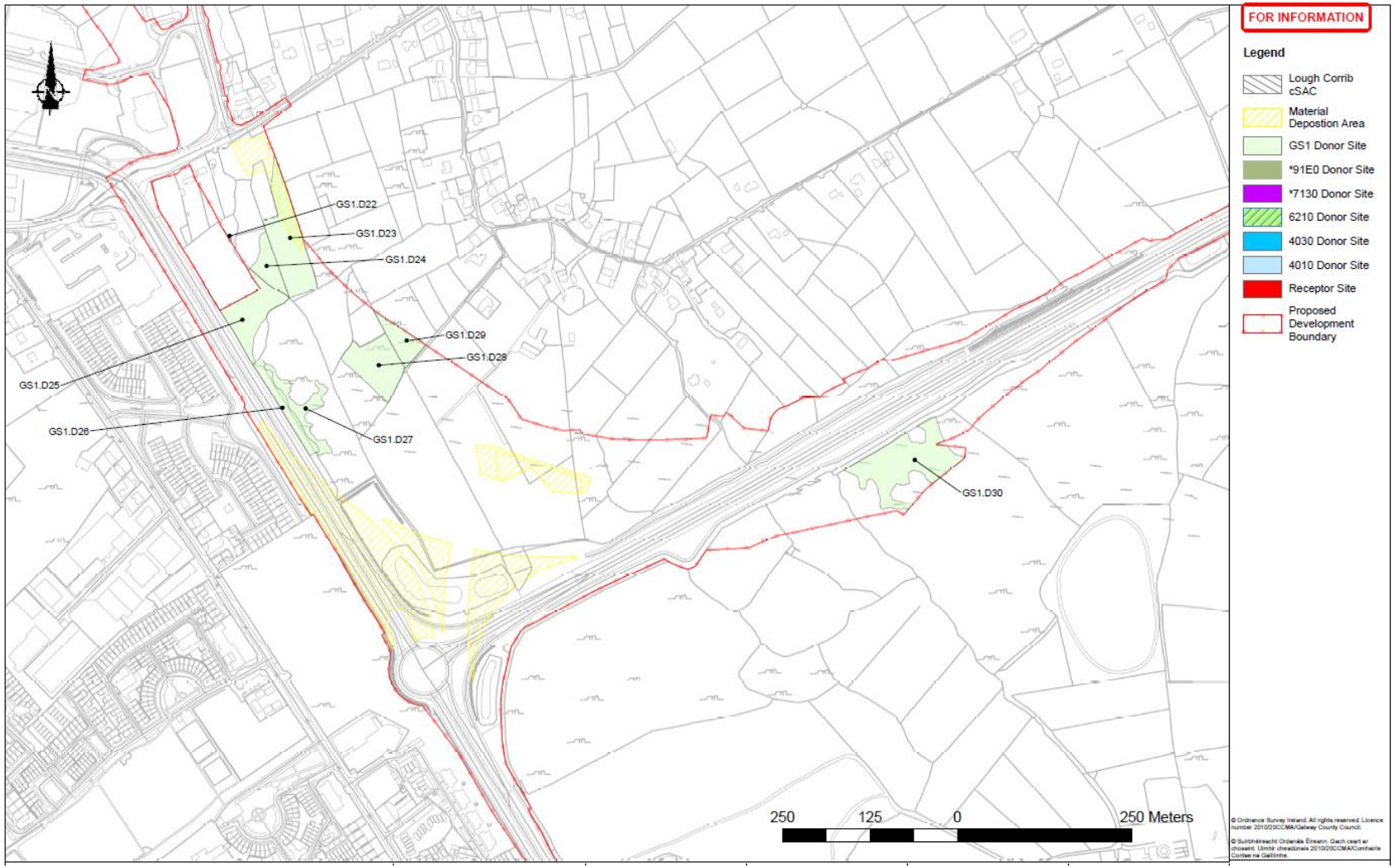

FOR INFORMATION
Legend
Lough Corrib cSAC
Material Depostion Area
GS1 Donor Site
*91E0 Donor Site
*7130 Donor Site
6210 Donor Site
4030 Donor Site
4010 Donor Site
Receptor Site
Proposed Development Boundary
GS1.D21
GS1.D20
250
125
0
250 Meters

Figure 9

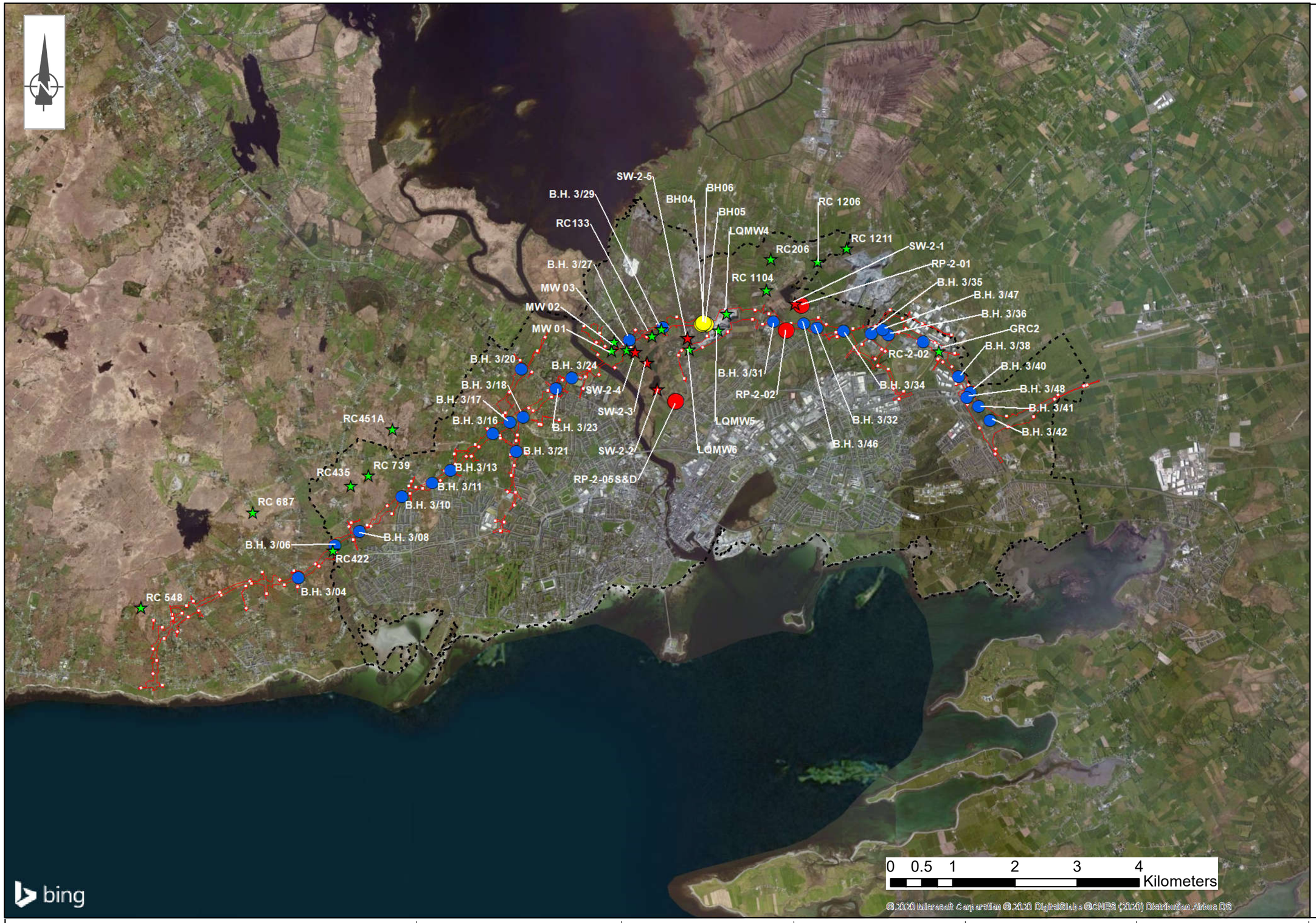

FOR INFORMATION
Legend
Lough Corrib cSAC
Material Depostion Area
GS1 Donor Site
*91E0 Donor Site
*7130 Donor Site
6210 Donor Site
4030 Donor Site
4010 Donor Site
Receptor Site
Proposed Development Boundary
GS1.D22
GS1.D23
GS1.D24
GS1.D25
GS1.D26
GS1.D27
GS1.D28
GS1.D29
GS1.D30
250
125
0
250 Meters

Appendix D

Groundwater Monitoring

D1

A3



FOR INFORMATION

Legend

- City Boundary
- Proposed Development Boundary
- Pre-existing monitoring wells
- Monitoring wells installed as part of GI
- Additional monitoring wells installed at lackagh tunnel
- Surface water monitoring as sensitive limestone locations
- Wells at sensitive limestone locations

Clients

Comhairle Chontae na Gaillimhe
Galway County Council

N6 Galway City Transport Project

An Roinn Iompair Turasóireachta agus Spóirt
Department Transport, Tourism and Sport

Transport Infrastructure Ireland

Consultant

ARUP

Corporate House
City East Business Park
Ballybrit, Galway
www.arup.com

Job Title
N6 Galway City Ring Road

Scale:

Date: **March 2020**

Issue	Date	By	Chkd	Appd
I1	06/03/2020	AG	LB	EMC

Locations of groundwater monitoring network

Drawing Status
For Information

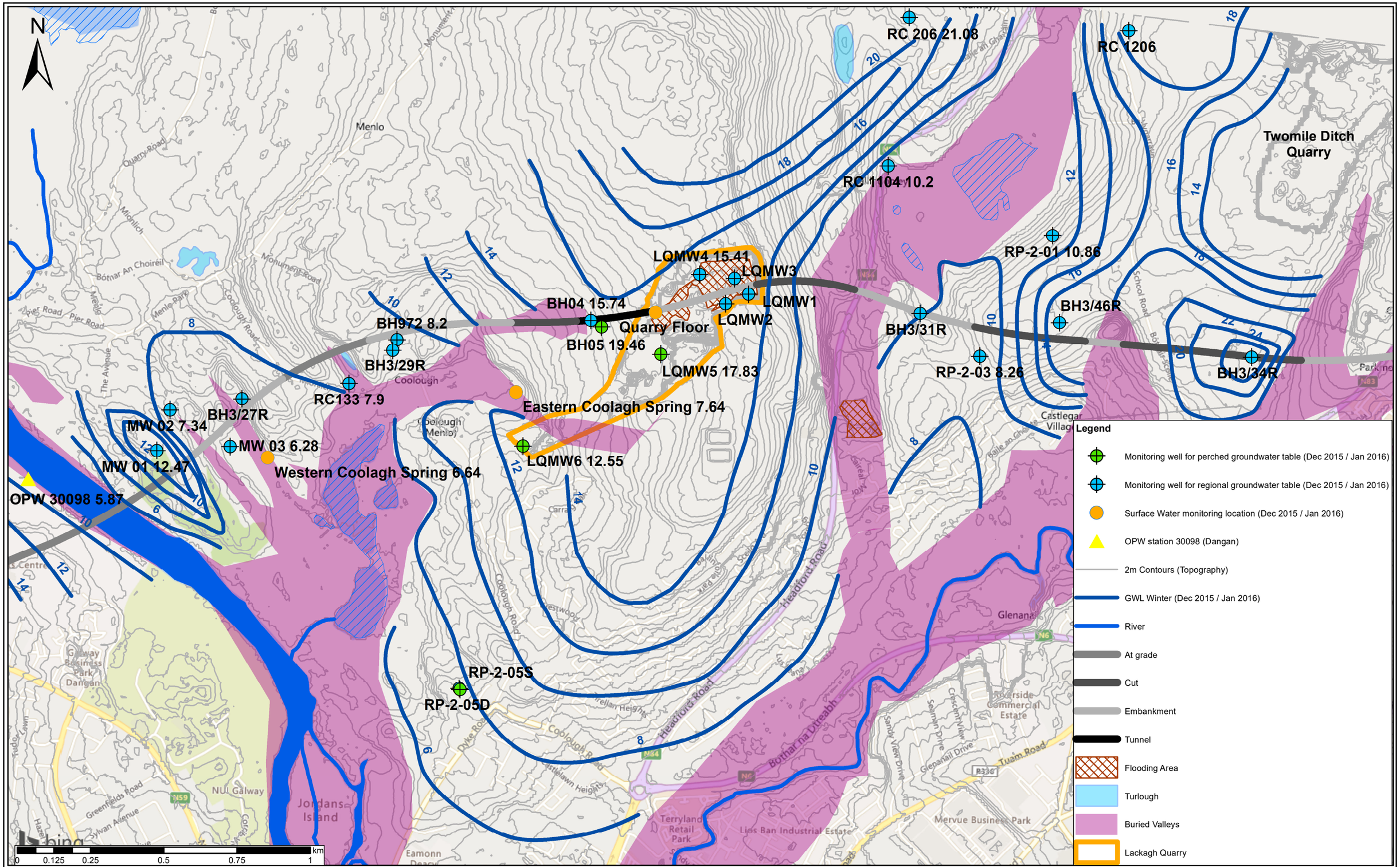
Job No	Drawing No	Issue
233985-00	**Figure 1**	**I1**

Table 1: Summary of all groundwater and surface water monitoring locations in the GCRR hydrogeology monitoring network

Monitoring Point	Ground elevation mOD	Groundwater body	Geology	Response zone mOD	Monitoring Start	Monitoring End	No. of Manual records	Notes
RC422	21.20	Spiddal GWB	Granite	17.54 to 14.54	25/06/2015	28/09/2016	14	
RC435	59.19	Spiddal GWB	Granite	53.73 to 51.73	25/06/2015	28/09/2016	14	
RC451A	71.70	Spiddal GWB	Granite	65.05 to 62.05	25/06/2015	28/09/2016	14	Electronic logger
RC 548	50.84	Spiddal GWB	Granite	43.38 to 43.08	25/06/2015	28/09/2016	14	
RC 687	69.56	Spiddal GWB	Granite	59.09 to 58.79	25/06/2015	28/09/2016	14	
RC 739	59.64	Spiddal GWB	Granite	57.84 to 51.84	25/06/2015	28/09/2016	14	
BH-3-04R	36.82	Spiddal GWB	Granite	35.84 to 31.32	11/03/2016	16/11/2016	9	
BH-3-06R	23.09	Spiddal GWB	Granite	22.41 to 20.91	11/03/2016	06/12/2016	10	
BH-3-08R	42.05	Spiddal GWB	Granite	38.50 to 32.50	11/03/2016	16/11/2016	8	
BH-3-10R	66.51	Spiddal GWB	Granite	61.01 to 55.51	14/04/2016	16/11/2016	7	
BH-3-11R	54.24	Spiddal GWB	Granite	52.44 to 51.54	11/03/2016	16/11/2016	9	
BH-3-13R	58.65	Spiddal GWB	Granite	52.65 to 48.55	11/03/2016	16/11/2016	6	
BH-3-16R	61.66	Spiddal GWB	Granite	55.66 to 51.66	11/03/2016	16/11/2016	7	
BH-3-17R	65.33	Maam Clonbur GWB	Granite	62.56 to 55.36	21/03/2016	16/11/2016	9	
BH-3-18R	70.64	Maam Clonbur GWB	Granite	70.14 to 46.14	21/03/2016	16/11/2016	7	
BH-3-20R	51.63	Maam Clonbur GWB	Granite	45.63 to 36.63	14/04/2016	16/11/2016	7	
BH-3-21	37.76	Maam Clonbur GWB	Subsoil	36.66 to 35.96	14/04/2016	16/11/2016	4	Subsoil
BH-3-23R	26.93	Maam Clonbur GWB	Granite	22.43 to 21.23	21/03/2016	16/11/2016	8	
BH-3-24R	25.16	Maam Clonbur GWB	Granite	22.66 to 18.16	21/03/2016	16/11/2016	8	
MW01	16.14	Lough Corrib Fen 1 (Menlough)	Limestone	11.43 to 2.43	15/06/2015	06/11/2016	16	Electronic logger
MW02	13.37	Lough Corrib Fen 1 (Menlough)	Limestone	7.54 to -4.20	15/06/2015	06/11/2016	16	Electronic logger
MW03	6.70	Lough Corrib Fen 1 (Menlough)	Limestone	3.90 to -5.10	15/06/2015	17/04/2017	19	Electronic logger
SW-2-04	5.41	Lough Corrib Fen 1 (Menlough)	Limestone	Western Coolagh Spring	15/06/2015	20/07/2016	5	Electronic logger
BH-3-27R	9.10	Lough Corrib Fen 1 (Menlough)	Limestone	4.30 to -2.70	14/04/2016	09/11/2016	4	Access problems
RC133	11.66	Lough Corrib Fen 1 (Menlough)	Limestone	4.56 to-1.54	26/02/2015	17/04/2017	21	Electronic logger
BH-3-29R	13.73	Lough Corrib Fen 1 (Menlough)	Limestone	10.12 to 7.12	14/04/2016	06/11/2016	3	Access problems
SW-2-05	7.06	Lough Corrib Fen 1 (Menlough)	Subsoil	Eastern Coolagh Spring	15/06/2015	20/07/2016	5	Electronic logger
BH972	12.33	Lough Corrib Fen 1 (Menlough)	Limestone	4.56 to 1.56	26/02/2015	02/12/2015	2	Replaced by BH-3-29R
RP-2-05D	19.96	Clare-Corrib GWB	Limestone	18.96 to -15.04	29/09/2015	07/12/2016	14	Electronic logger
RP-2-05S	20.22	Clare-Corrib GWB	Limestone	19.22 to 8.22	29/09/2015	07/12/2016	14	Electronic logger
LQMW6	15.40	Clare-Corrib GWB	Limestone (response zone straddles a shale bed)	15.40 to -4.07	04/06/2015	06/12/2016	17	Electronic logger

Monitoring Point	Ground elevation mOD	Groundwater body	Geology	Response zone mOD	Monitoring Start	Monitoring End	No. of Manual records	Notes
BH04	32.17	Clare-Corrib GWB	Limestone (response zone below shale bed)	9.49 to -2.83	15/12/2015	03/11/2016	11	19mm piezo (below shale)
BH05	34.14	Clare-Corrib GWB	Limestone (response zone below shale bed)	11.54 to -5.84	15/12/2015	03/11/2016	11	19mm piezo (below shale)
BH06	30.80	Clare-Corrib GWB	Subsoil	29.20m to 19.20	15/12/2015	03/11/2016	11	19mm piezo Buried Valley
LQMW5	7.40	Clare-Corrib GWB	Limestone (response zone straddles a shale bed)	25.38 to - 5.07	24/06/2015	11/04/2017	16	
LQMW4	16.76	Clare-Corrib GWB	Limestone	16.88 to -7.37	26/04/2015	06/12/2016	19	Electronic logger
RC1104	9.39	Clare-Corrib GWB	Limestone	-9.62 to -9.92	24/06/2015	09/12/2016	11	
BH-3-31R	11.08	Clare-Corrib GWB	Limestone	6.34 to 1.34	14/04/2016	18/06/2016	3	Access problems
RC206	28.49	Clare-Corrib GWB	Limestone	27.92 to 14.66	24/06/2015	09/12/2016	17	
SW-2-01	8.43	Clare-Corrib GWB	Subsoil	Ballindooley Lough	04/06/2015	16/07/2016	5	Electronic logger
SW-2-02	5.6	Clare-Corrib GWB	Subsoil	Coolagh Lake Lower	04/06/2015	21/12/2015	6	
SW-2-03	5.47	Clare-Corrib GWB	Subsoil	Coolagh Lake Upper	04/06/2015	21/12/2015	6	
RP-2-03	22.44	Clare-Corrib GWB	Limestone	21.44 to -12.56	29/09/2015	08/12/2016	13	Electronic logger
RP-2-01	21.38	Clare-Corrib GWB	Limestone	20.38 to-13.62	29/09/2015	08/12/2016	14	Electronic logger
BH-3-46R	29.81	Clare-Corrib GWB	Limestone	18.31 to 11.41	21/03/2016	09/11/2016	8	
RC1206	27.67	Clare-Corrib GWB	Limestone	19.45 to 16.45	26/02/2015	08/12/2016	16	
BH-3-32R	24.43	Clare-Corrib GWB	Limestone	17.79 to 9.79	18/08/2016	18/08/2016	1	
RC1211	25.91	Clare-Corrib GWB	Limestone	19.51 to 19.21	26/02/2015	30/09/2016	15	
BH-3-34R	32.57	Clare-Corrib GWB	Limestone	24.07 to 15.17	14/04/2016	09/11/2016	7	
BH-3-35R	17.52	Clare-Corrib GWB	Subsoil	7.02 to -1.98	14/04/2016	09/11/2016	7	Buried valley
BH-3-47R	37.74	Clarinbridge GWB	Limestone	30.74 to 24.24	14/04/2016	06/11/2016	5	
BH-3-36R	51.78	Clarinbridge GWB	Limestone	40.54 to 32.29	16/03/2016	06/11/2016	13	
RC-2-02	54.92	Clarinbridge GWB	Limestone	50.58 to 40.58	29/09/2015	06/11/2016	5	Well damaged
GRC1	53.22	Clarinbridge GWB	Limestone	Private pumping well	09/06/2016	02/11/2016	11	Pumping wells are not used in analysis
BH-3-38R	45.17	Clarinbridge GWB	Limestone	42.64 to 35.14	11/03/2016	06/12/2016	15	
BH-3-40R	42.39	Clarinbridge GWB	Limestone	40.14 to 32.54	11/03/2016	08/12/2016	13	
BH-3-41R	41.49	Clarinbridge GWB	Limestone	39.24 to 34.24	11/03/2016	23/01/2017	13	
BH-3-42R	32.60	Clarinbridge GWB	Limestone	27.53 to 23.03mOD	16/03/2016	23/01/2017	14	
BH-3-48R	40.48	Clarinbridge GWB	Limestone	30.83 to 20.33mOD	11/03/2016	08/12/2016	13	

A3



Clients

Comhairle Chontae na Gaillimhe Galway County Council

N6 Galway City Transport Project

An Roinn Iompair Turasóireachta agus Spóirt Department of Transport, Tourism and Sport

TII Bonneagar Iompair Éireann Transport Infrastructure Ireland

Key Plan

Consultant

ARUP

Corporate House
City East Business Park
Ballybrit, Galway, Ireland

Tel +353 (0)91 460675
www.N6GalwayCity.ie
www.arup.ie

Job Title
N6 Galway City Ring Road

Scale:

Date: **March 2020**

All elevations mOD

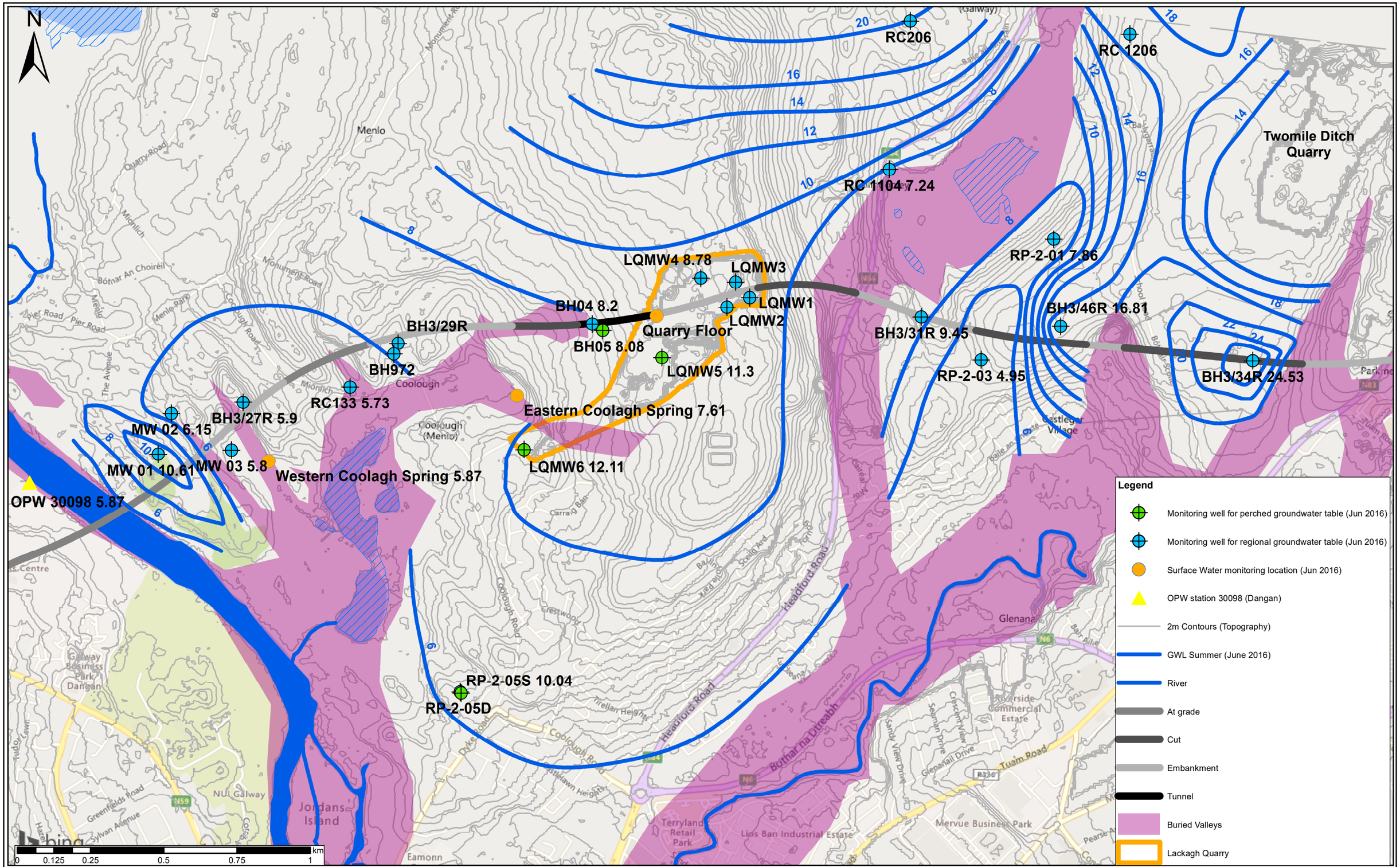
Issue	Date	By	Chkd	Appd
I1	04/03/2020	MK	LB	CB

Drawing Title
Winter Groundwater Levels

Drawing Status
For Information

Job No	Drawing No	Issue
233985-00	Appendix D-2	I1

A3



Clients

Comhairle Chontae na Gaillimhe
Galway County Council

N6 Galway City Transport Project

An Roinn Iompair Turasóireachta agus Spóirt
Department of Transport, Tourism and Sport

TII Transport Infrastructure Ireland

Key Plan

Consultant

ARUP

Corporate House
City East Business Park
Ballybrit, Galway, Ireland

Tel +353 (0)91 460675
www.N6GalwayCity.ie
www.arup.ie

Job Title
N6 Galway City Ring Road

Scale:

Date: **March 2020**

All elevations mOD

Issue	Date	By	Chkd	Appd
I1	04/03/2020	MK	LB	CB

Drawing Title
Summer Groundwater Levels

Drawing Status
For Information

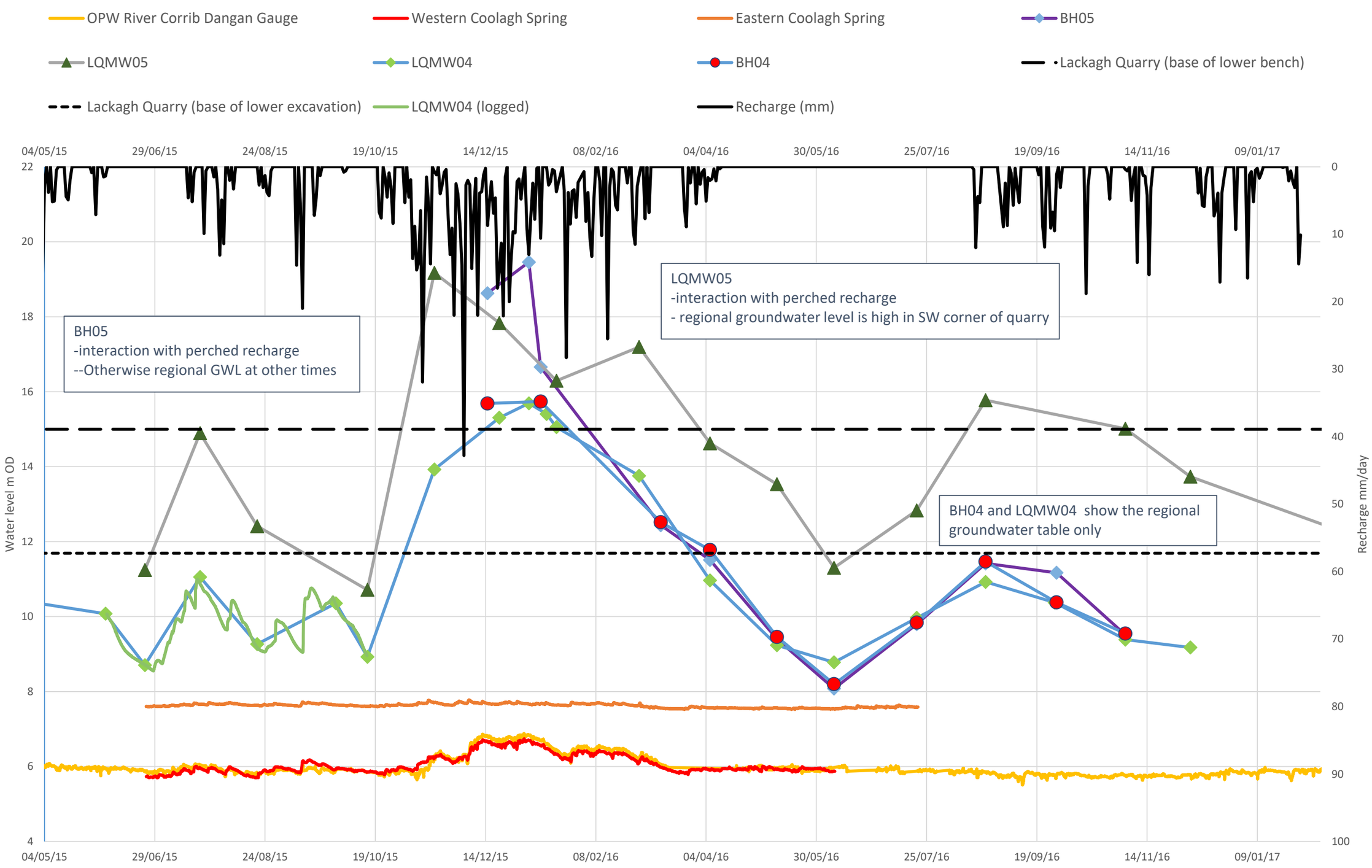
Job No	Drawing No	Issue
233985-00	Appendix D-3	I1

Appendix E

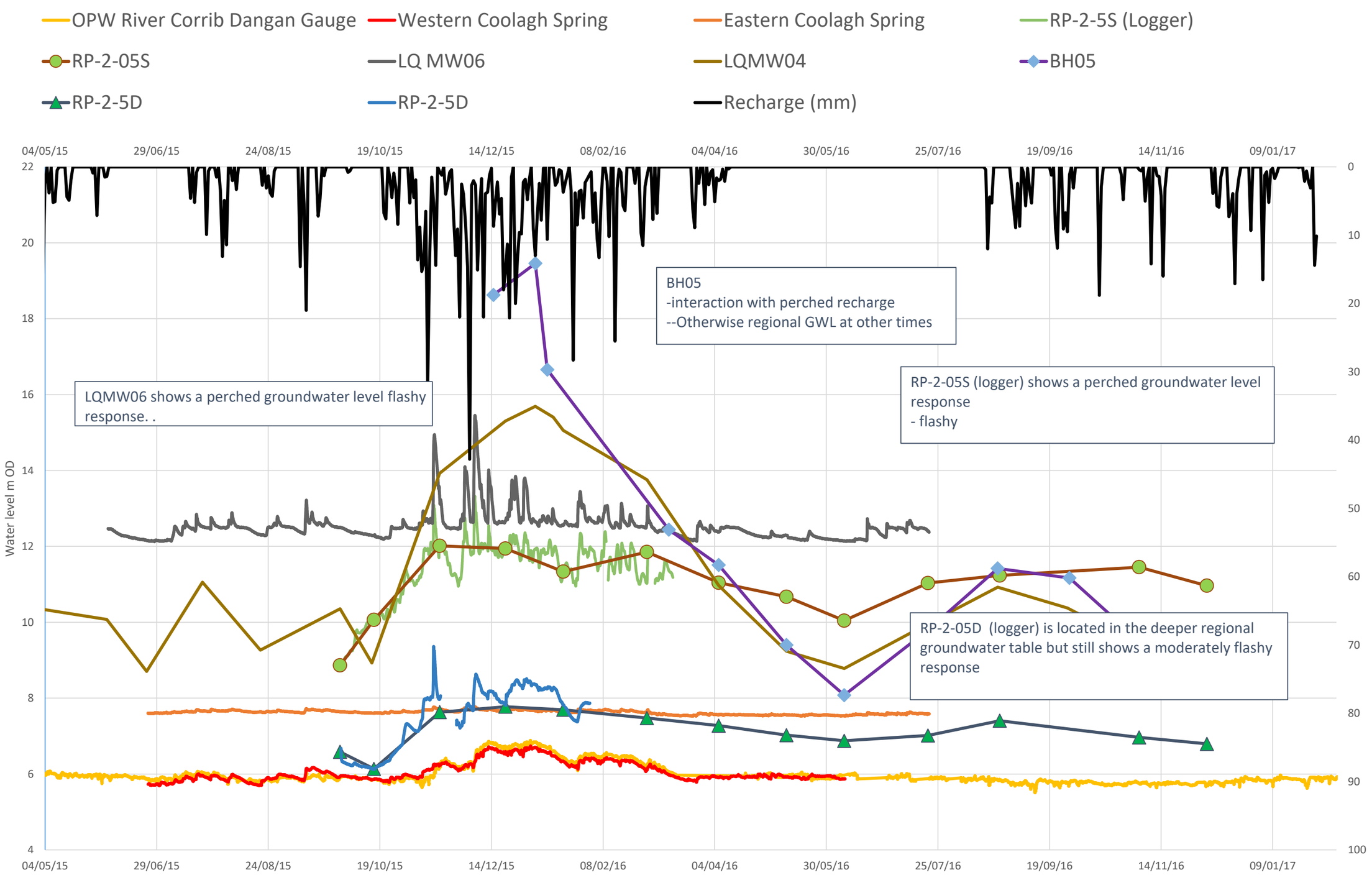
Hydrographs

E1

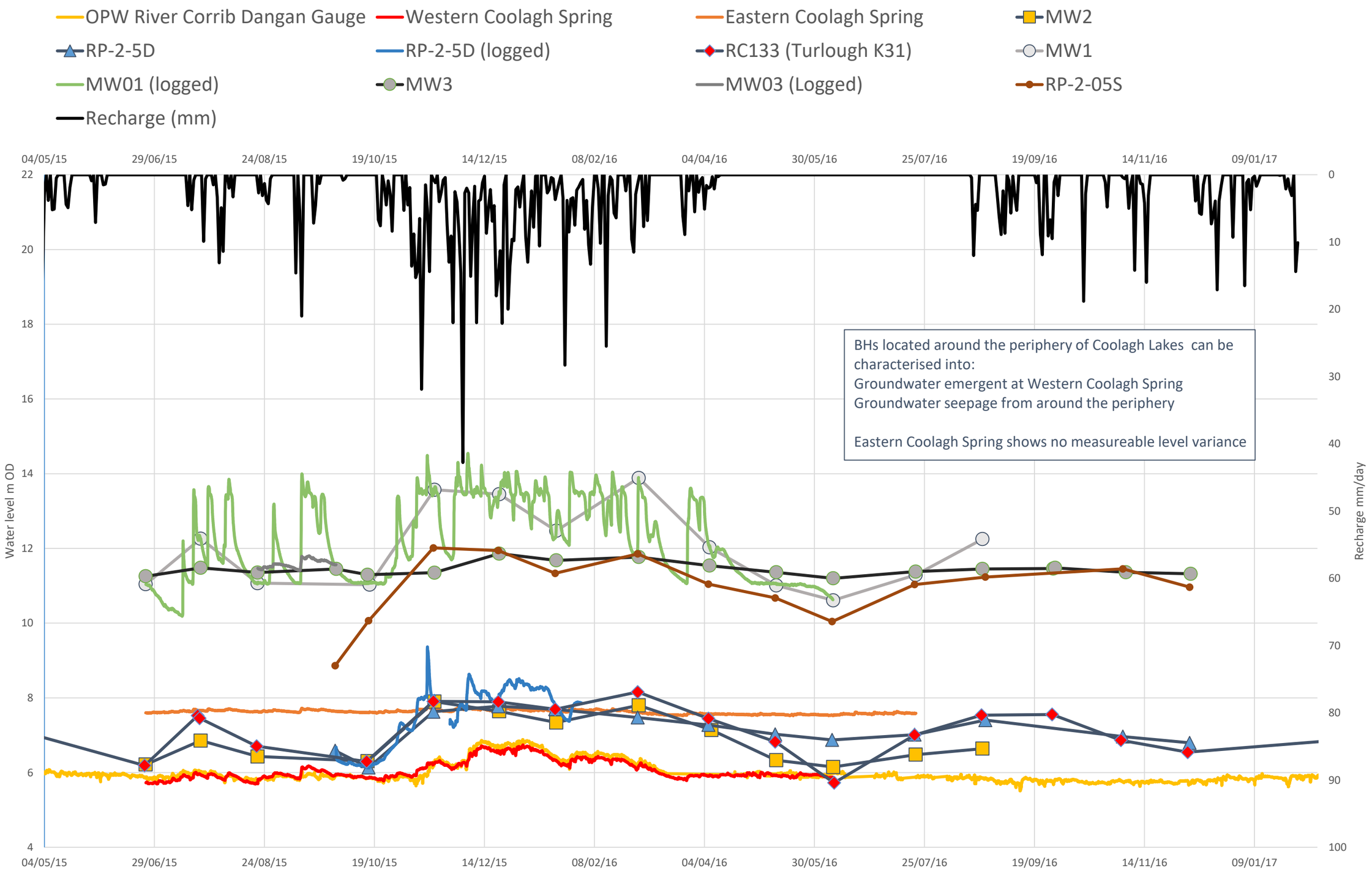
APPENDIX E - Hydrograph i: Groundwater and surface water levels - River Corrib to Lackagh Quarry
Characterising groundwater levels at Lackagh Quarry



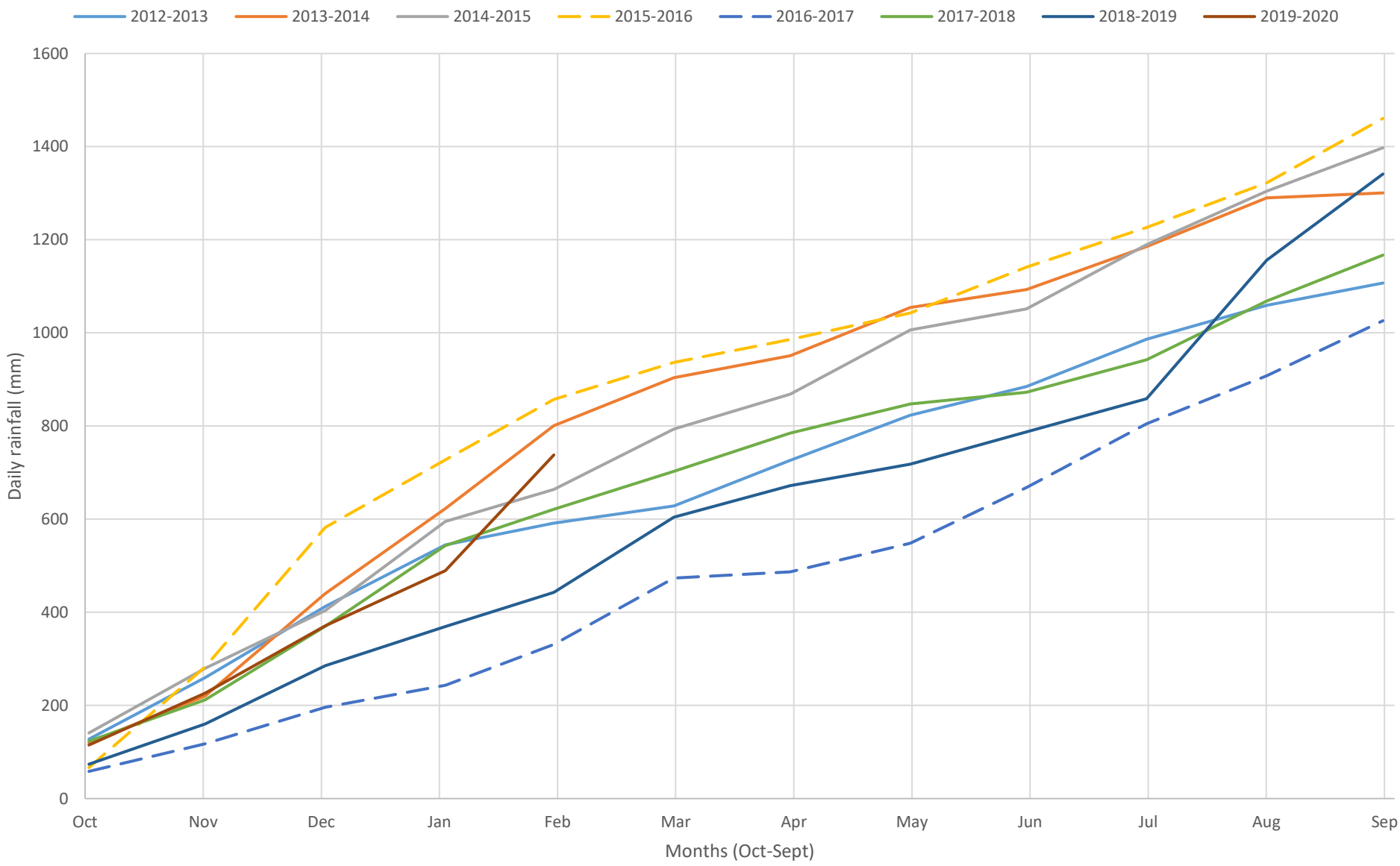
APPENDIX E - Hydrograph ii: Groundwater and surface water levels River Corrib to Lackagh Quarry
Characterising groundwater perched by the shale bed



APPENDIX E - Hydrograph iii: Groundwater and surface water levels River Corrib to Lackagh Quarry
Characterising groundwater contributions to Coolagh Lakes (Lough Corrib cSAC)



Appendix E: Cumulative rainfall plot (Hydro year Oct-Sept)

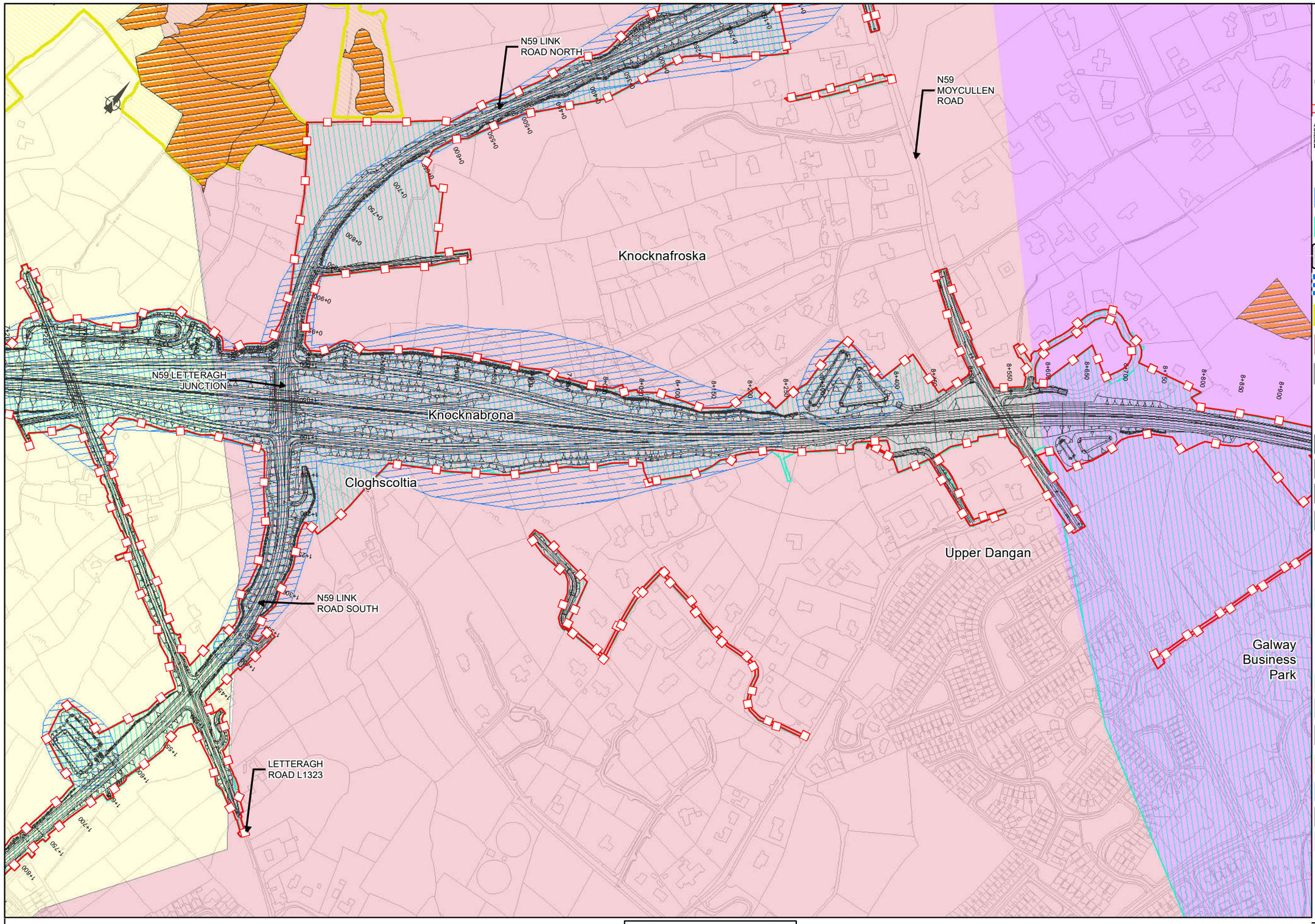


Appendix F

EIAR Figures

F1

A3



EIA REPORT

Legend

- City Boundary
- Proposed Development Boundry
- Proposed Road Development

Potential Impacts

- Drawdown Zone of Influence
- Area Liable to Contamination
- candidate Special Area of Conservation
- Special Areas of Conservation (SPA)
- National Heritage Areas (NHA)
- Potential National Heritage Areas (pNHA)
- Estimatated Palaeolandscapes extents

Groundwater Receptors

- Wells 50m
- Wells 100m
- Wells 500m
- Wells 1km
- Groundwater Dependant habitat
- Groundwater Seepage Points

Groundwater Bodies (2017)

- Clare - Corrib (Terryland) GWB
- Clare-Corrib (Ballindooley East) GWB
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- Clarinbridge GWB
- Maam-Clonbur GWB
- Lough Corrib Fen 1 (Lackagh) GWB
- Lough Corrib Fen 1 (Menlough) GWB
- Lough Corrib Fen 2 GWB
- Spiddal GWB
- Ross Lake GWB

Clients

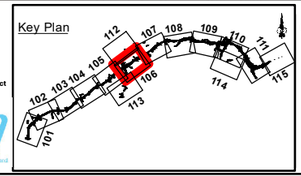
Comhairle Chontae na Gaillimhe
Galway County Council

N6 Galway City Transport Project

An Roinn Iompair Turasóireachta agus Spóirt
Department Transport, Tourism and Sport

TII Transport Infrastructure Ireland

Key Plan



Consultant

ARUP

Corporate House
City East Business Park
Ballybrit, Galway, Ireland

Tel +353 (0)91 460675
www.N6GalwayCity.ie
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Job Title
N6 Galway City Ring Road

Scale: **1:5,000**

Date: **February 2020**

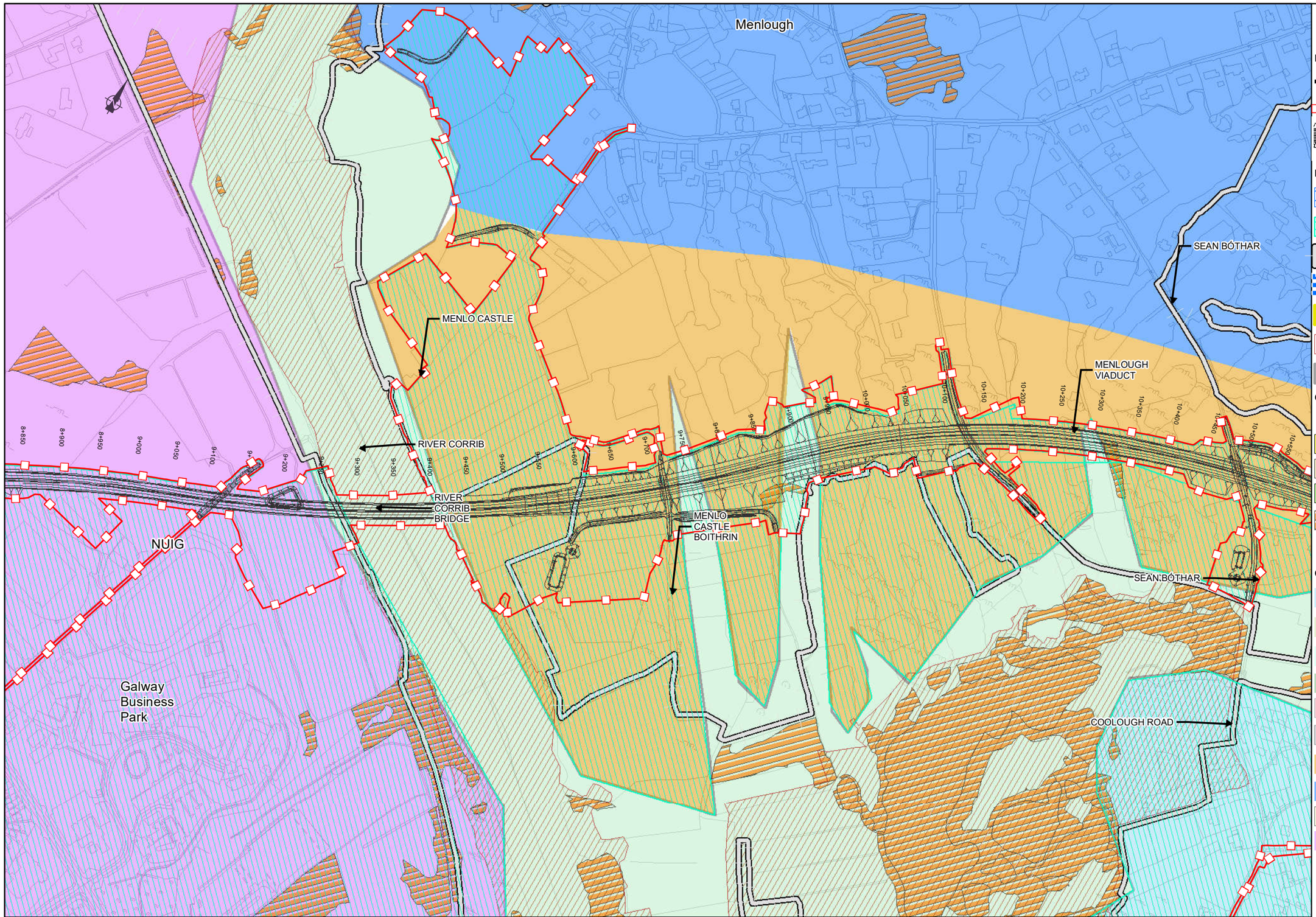
Issue	Date	By	Chkd	Appd
I3	03/03/2020	AG	MH	EMC
I2	19/02/2020	JOT	MH	EMC
I1	28/09/2018	KJ	MH	EMC

Drawing Title
Construction Zone of Influence (ZoI)
Sheet 06 of 15

Drawing Status
FOR INFORMATION

Job No	Drawing No	Issue
233985-00	**Figure 10.7.106**	**I3**

A3



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Clients

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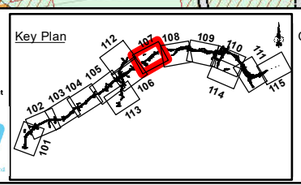
Galway County Council

Galway City Transport Project

An Roinn Iompair Túrasóireachta agus Spóirt
Department Transport, Tourism and Sport

TII
Údarás Náisiúnta Iompair
National Transport Authority

Key Plan



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Drawing Title
Construction Zone of Influence (ZoI) Sheet 07 of 15

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FOR INFORMATION

Job No	Drawing No	Issue
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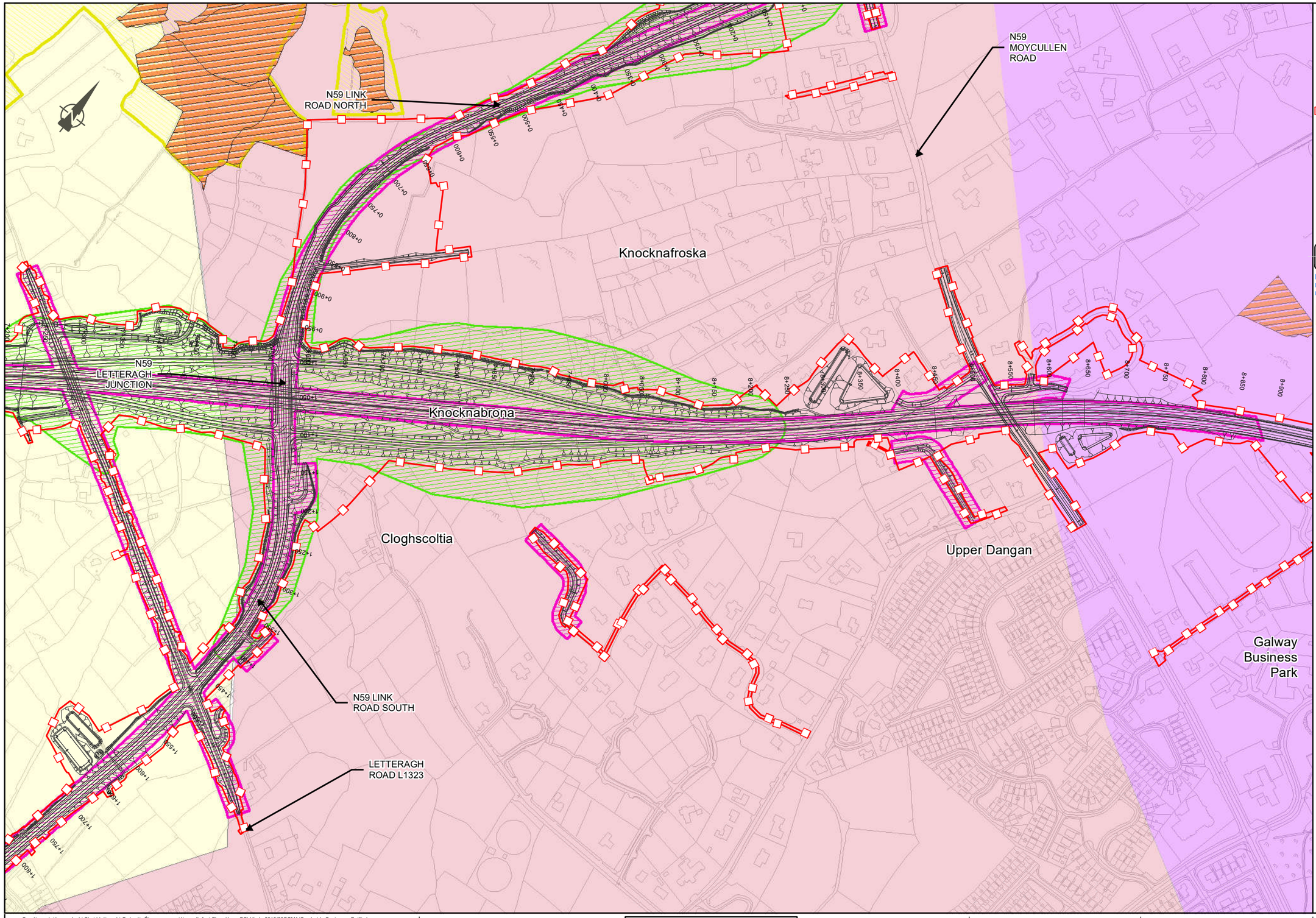
A3



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- Groundwater Seepage Points

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Galway County Council

N6 Galway City Transport Project

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Department Transport, Tourism and Sport

Transport Infrastructure Ireland

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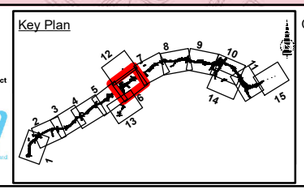

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Operation Zone of Influence (ZoI) Sheet 06 of 15

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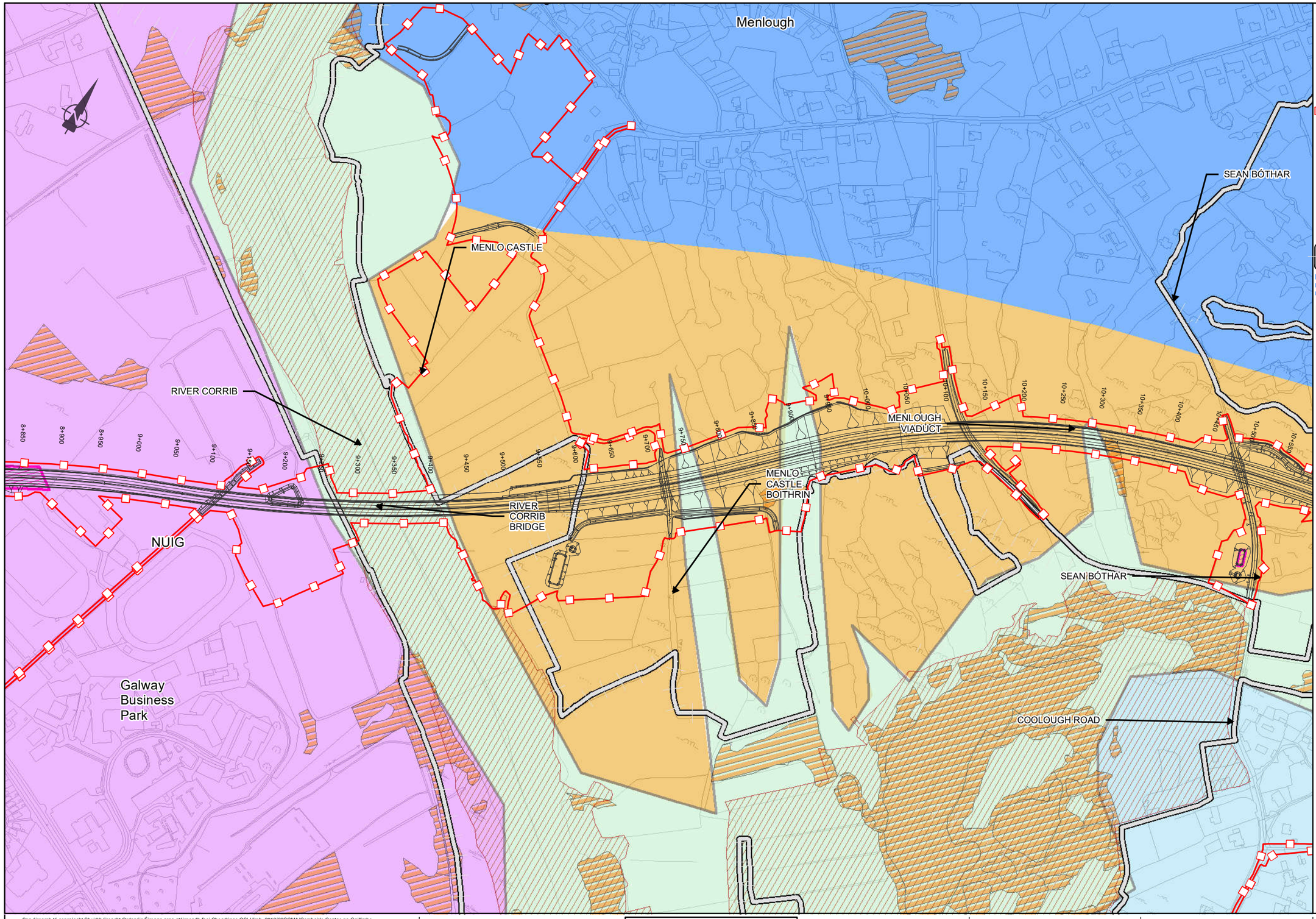
FOR INFORMATION

Job No	Drawing No	Issue
233985-00	**Figure 10.8.106**	**I3**

A3



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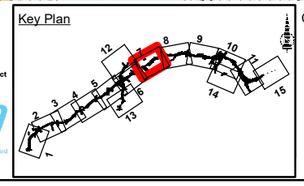

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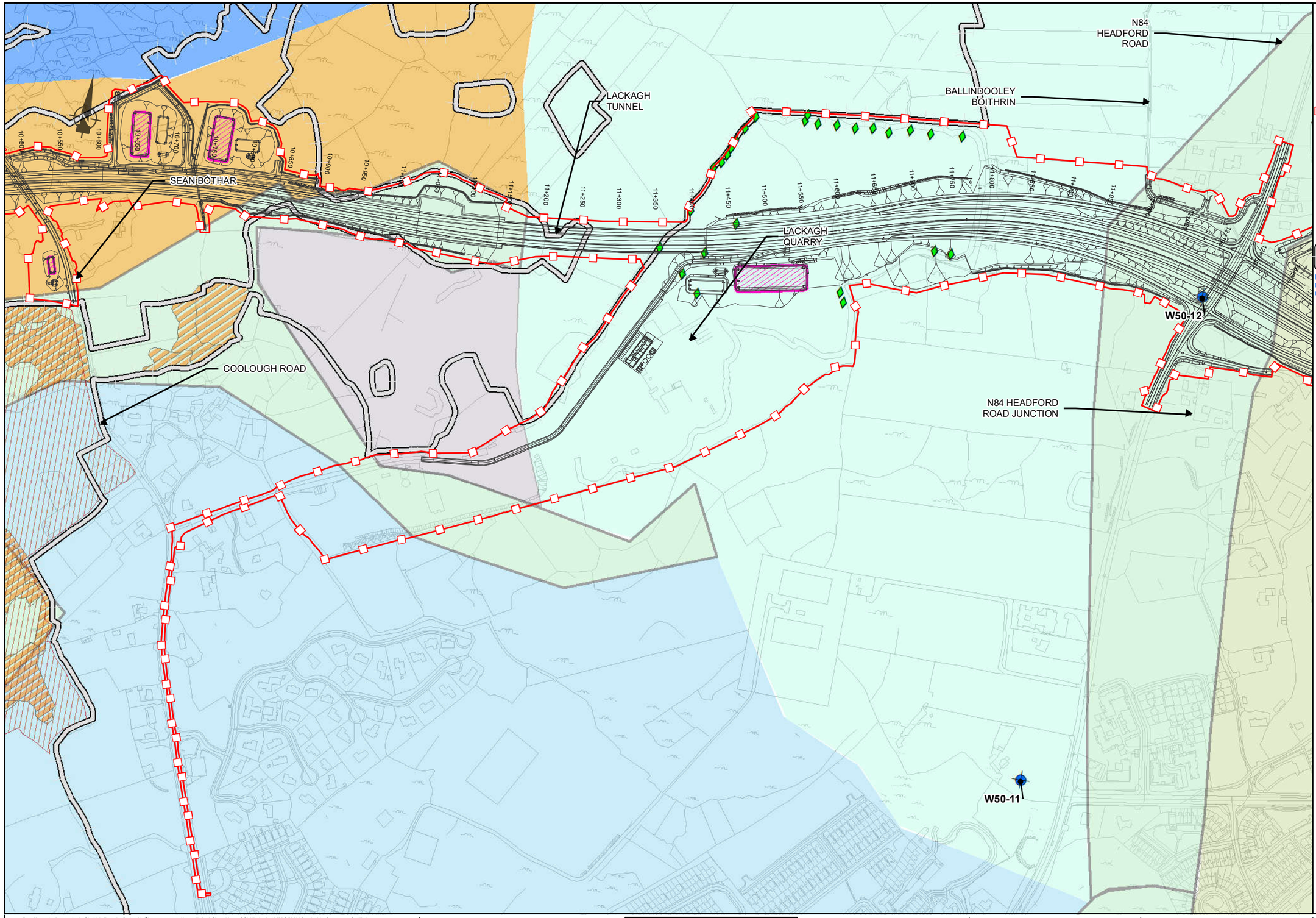
I1	28/09/2018	KJ	MH	EMC

Drawing Title
Operation Zone of Influence (ZoI)
Sheet 07 of 15

Drawing Status
FOR INFORMATION

Job No	Drawing No	Issue
233985-00	**Figure 10.8.107**	**I3**

A3



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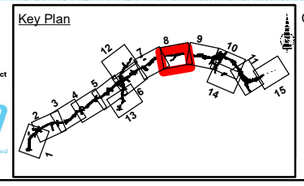
Clients: Comhairle Chontae na Gaillimhe Galway County Council; Galway City Transport Project; An Roinn Iompair Turasóireachta agus Spóirt Department Transport, Tourism and Sport; Transport Infrastructure Ireland

Key Plan



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Corporate House, City East Business Park, Ballybrit, Galway, Ireland
Tel +353 (0)91 460675
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Date: **September 2018**

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I3	03/03/2020	AG	MH	EMC
I2	19/02/2020	AM	MH	EMC
I1	28/09/2018	KJ	MH	EMC

Drawing Title: **Operation Zone of Influence (ZoI) Sheet 08 of 15**

Drawing Status: **FOR INFORMATION**

Job No	Drawing No	Issue
233985-00	Figure 10.8.108	I3

A3

Ballindooley Lough

SCHOOL ROAD

HYNES' BOITHRIN

SPELLMAN'S BOITHRIN

CITY NORTH BUSINESS PARK JUNCTION

Castlegar

BOTHAR NA CHOISTE

Ballinfoyle

CITY NORTH BUSINESS PARK LINK

EIA REPORT

Legend

- CityBoundary
- Proposed Development Boundary
- Proposed Road Development

Potential Impacts

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- Estimatated Palaeolandscapes extents

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- Wells 500m Accuracy
- Wells 1km Accuracy
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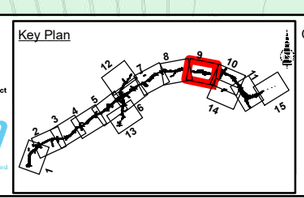
Key Plan



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Job Title: **N6 Galway City Ring Road**

Scale: **1:5,000**

Date: **September 2018**

Issue	Date	By	Chkd	Appd
I3	03/03/2020	AG	MH	EMC
I2	19/02/2020	AM	MH	EMC
I1	28/09/2018	KJ	MH	EMC

Drawing Title: **Operation Zone of Influence (ZoI) Sheet 09 of 15**

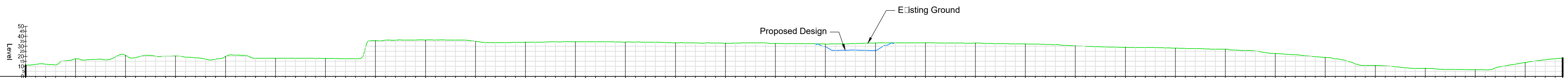
Drawing Status: **FOR INFORMATION**

Job No	Drawing No	Issue
233985-00	Figure 10.8.109	I3

Appendix G

Hydro-geological Cross-section
Castlegar Cut

G1



Chainage	E□isting Levels	Proposed Levels
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10.000	11.919	
20.000	12.150	
30.000	11.592	
40.000	15.591	
50.000	17.475	
60.000	16.402	
70.000	16.989	
80.000	16.490	
90.000	19.412	
100.000	20.911	
110.000	18.720	
120.000	21.027	
130.000	20.227	
140.000	20.158	
150.000	20.384	
160.000	19.145	
170.000	18.512	
180.000	17.281	
190.000	17.124	
200.000	19.890	
210.000	21.237	
220.000	20.966	
230.000	18.024	
240.000	18.054	
250.000	18.071	
260.000	18.076	
270.000	18.006	
280.000	17.979	
290.000	17.947	
300.000	17.909	
310.000	17.774	
320.000	17.619	
330.000	17.649	
340.000	29.208	
350.000	35.642	
360.000	36.099	
370.000	36.116	
380.000	36.201	
390.000	36.257	
400.000	36.296	
410.000	36.325	
420.000	36.271	
430.000	36.223	
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590.000	34.341	
600.000	34.171	
610.000	34.197	
620.000	34.073	
630.000	34.030	
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730.000	33.444	
740.000	33.390	
750.000	32.849	
760.000	32.683	
770.000	32.590	
780.000	32.598	
790.000	32.505	32.062
800.000	32.278	29.811
810.000	32.360	25.891
820.000	32.443	26.093
830.000	32.762	26.214
840.000	33.031	25.948
850.000	33.306	25.840
860.000	33.469	30.900
870.000	33.412	
880.000	33.435	
890.000	33.449	
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ALIGNMENT - Castlegar A-A - LONGSECTION in Natural Scale
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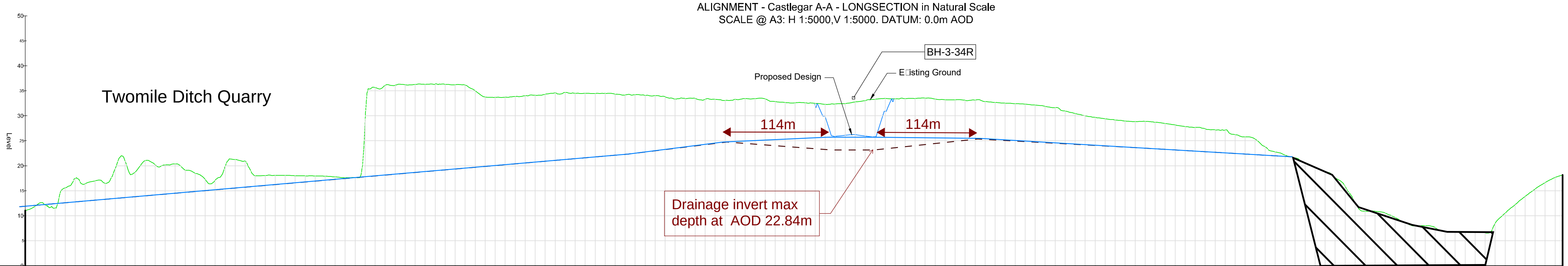

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340.000	29.208	
350.000	35.642	
360.000	36.099	
370.000	36.116	
380.000	36.201	
390.000	36.257	
400.000	36.296	
410.000	36.325	
420.000	36.271	
430.000	36.223	
440.000	36.162	
450.000	34.985	
460.000	33.739	
470.000	33.678	
480.000	33.713	
490.000	33.867	
500.000	34.014	
510.000	34.099	
520.000	34.309	
530.000	34.622	
540.000	34.672	
550.000	34.497	
560.000	34.485	
570.000	34.463	
580.000	34.505	
590.000	34.341	
600.000	34.171	
610.000	34.197	
620.000	34.073	
630.000	34.030	
640.000	33.800	
650.000	33.366	
660.000	33.461	
670.000	33.480	
680.000	33.307	
690.000	33.294	
700.000	33.083	
710.000	33.309	
720.000	33.437	
730.000	33.444	
740.000	33.390	
750.000	32.849	
760.000	32.683	
770.000	32.590	
780.000	32.598	
790.000	32.505	32.062
800.000	32.278	29.811
810.000	32.360	25.891
820.000	32.443	26.093
830.000	32.762	26.214
840.000	33.031	25.948
850.000	33.306	25.840
860.000	33.469	30.900
870.000	33.412	
880.000	33.435	
890.000	33.449	
900.000	33.543	
910.000	33.352	
920.000	33.197	
930.000	33.195	
940.000	33.100	
950.000	33.142	
960.000	32.847	
970.000	32.664	
980.000	32.528	
990.000	32.444	
1000.000	32.319	
1010.000	32.140	
1020.000	31.892	
1030.000	31.647	
1040.000	30.945	
1050.000	30.448	
1060.000	29.996	
1070.000	29.690	
1080.000	29.402	
1090.000	29.154	
1100.000	28.956	
1110.000	28.854	
1120.000	28.876	
1130.000	28.715	
1140.000	28.472	
1150.000	28.172	
1160.000	27.848	
1170.000	27.693	
1180.000	27.407	
1190.000	27.190	
1200.000	27.157	
1210.000	26.227	
1220.000	25.777	
1230.000	25.320	
1240.000	23.820	
1250.000	22.772	
1260.000	22.134	
1270.000	21.584	
1280.000	20.585	
1290.000	19.643	
1300.000	18.896	
1310.000	17.581	
1320.000	15.903	
1330.000	12.502	
1340.000	10.883	
1350.000	10.903	
1360.000	10.548	
1370.000	9.645	
1380.000	8.644	
1390.000	7.945	
1400.000	8.025	
1410.000	7.643	
1420.000	6.891	
1430.000	6.786	
1440.000	6.799	
1450.000	6.708	
1460.000	6.581	
1470.000	8.490	
1480.000	10.531	
1490.000	12.213	
1500.000	13.851	
1510.000	15.352	
1520.000	16.648	
1530.000	17.667	
1537.372	18.162	

ALIGNMENT - Castlegar A-A - LONGSECTION in 5x Exaggeration Scale
SCALE @ A3: H 1:5000,V 1:1000. DATUM: 0.0m AOD

Clients
An Roinn Iompair Turasóireachta agus Spóirt
Project Ireland 2040
Galway City Transport Project
Comhairle Chontae na Gaillimhe
Galway County Council

Consultant
ARUP
Corporate House
City East Business Park
Ballybrit, Galway, Ireland.
Tel +353 (0)91 460675
www.N6GalwayCity.ie
www.arup.ie

Job Title
N6 Galway City Ring Road

Scale: @A3 H 1:5000 , V - See Pro□ile Scale
Date: March 2020

Issue	Date	By	Chkd	Appd
I2	05/03/2020	KJ	LB	EMC
I1	02/03/2020	KJ	LB	EMC

Drawing Title
E□isting Ground □ Proposed Design
Cross Section Castlegar A-A

Drawing Status
For Information

Job No	Drawing No	Issue
233985-00	GCOB-SK-OH-041	I2

Do not scale